HIGH-TEMPERATURE CYCLIC OXIDATION DATA

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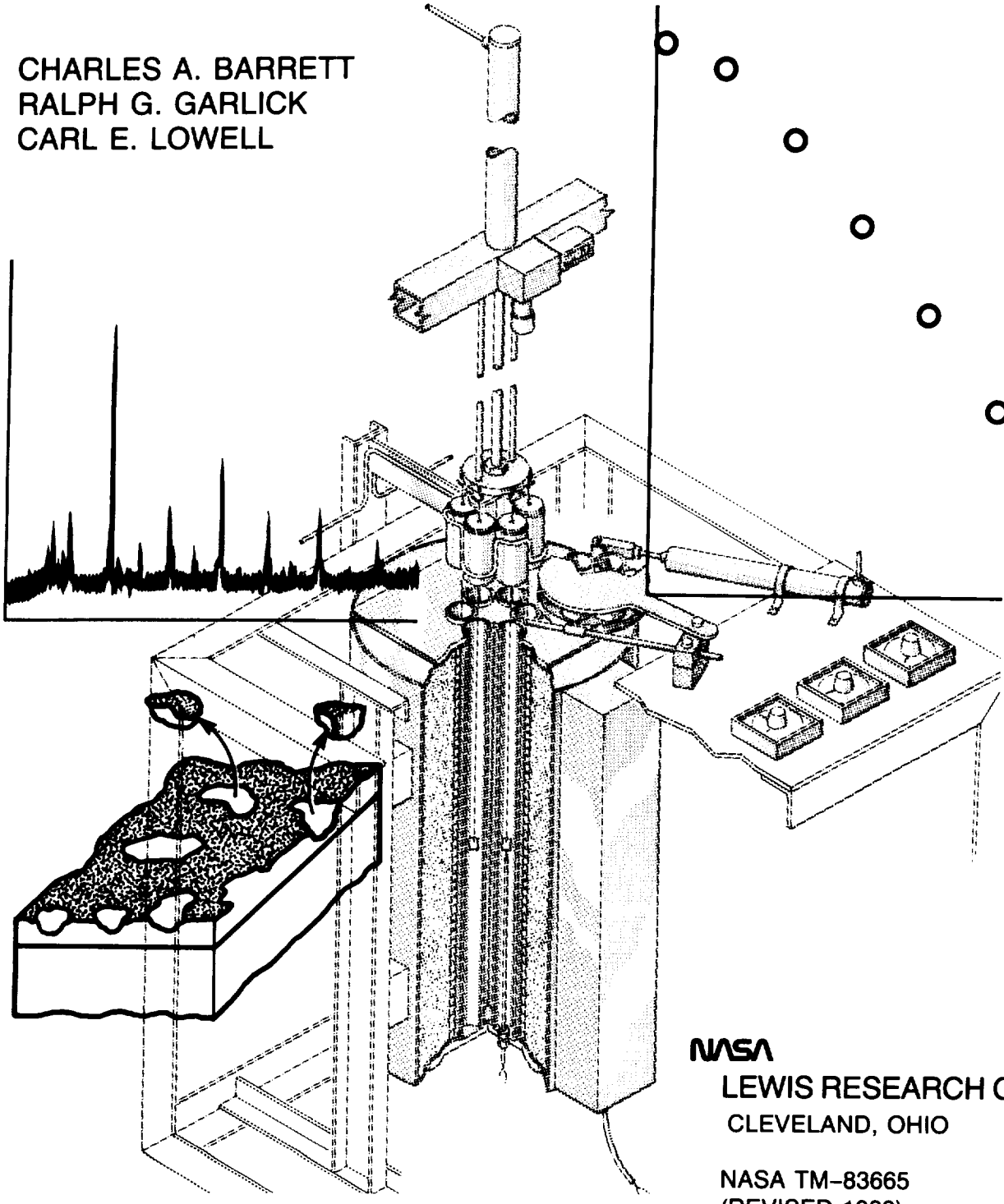

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TURBINE ALLOYS, PART 1
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High-Temperature Cyclic Oxidation Data

Turbine Alloys, Part 1

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Contents

Summary

To make the large body of cyclic oxidation data collected at NASA Lewis Research Center widely available, Lewis is publishing a series of cyclic oxidation handbooks. This first part in that series contains specific-weight-change-versus-time data and x-ray diffraction results derived from high-temperature cyclic tests on high-temperature, high-strength nickel-base γ/γ' and cobalt-base turbine alloys. Each page of data summarizes a complete test on a given alloy sample. Part 2 of the series, which contains data for the remainder of the high-temperature, high-strength nickel-base γ/γ' and cobalt-base turbine alloys tested at Lewis, is available as NASA Technical Memorandum 101468.

Introduction

High-temperature oxidation literature is concerned mainly with isothermal testing. This has led to a large body of oxide growth and transport property data. However, most applications for high-temperature materials are cyclic. During cyclic oxidation the degree of spalling is as important in estimating total metal loss as the growth rate of the oxide is in determining metal consumption (ref. 1). Oxidation studies at Lewis Research Center have focused on cyclic testing, both furnace and burner rig. The goal of these studies is to evaluate the mechanisms of material degradation in order to formulate cyclic oxidation models for predicting life (ref. 1).

As these studies proceeded, standard testing methods were developed (refs. 1 to 6) and a large body of cyclic oxidation data was collected. Some of these data have been reported as the results of specific investigations, but most have never found their way into print. To make these data useful to as many interested members of the oxidation research community as possible, NASA Lewis is publishing a series of cyclic oxidation handbooks. This first volume contains specific-weight-change-versus-time data and available x-ray diffraction results derived from high-temperature cyclic tests on high-temperature, high-strength nickel-base γ/γ' and cobalt-base turbine alloys. Table I lists these alloys in the order in which the data are presented. The alloy composition is detailed in part 2 of this series (NASA TM-101468).The details of testing, deriving, and analyzing the data are discussed in reference 7.

Oxidation Data

The data are presented in the following manner: each page summarizes a complete test on a given alloy sample. The heading on each page gives the test conditions and the nature of the alloy. The number in the upper right corner of the page completely codes and identifies the test for computer processing. For example, with 02-04-019-115-1, 02 means nickel base; 04 means commercial cast γ/γ' alloys; and 019 designates the alloy (in this case TAZ-8A). The last four numbers (115-1) are unique and refer to the NASA Lewis test run and test position.

Under the descriptive heading the specific-weight-change-versus-time data are both plotted and listed. X-ray diffraction data are listed where available. The results are separated into surface data and spall data. The phases are given in decreasing order of intensity. If the matrix can be identified through the scale, this information is included. If the x-ray results were obtained after various times, they are listed from the shortest to the longest test times. Table II lists the sample surface conditions that might qualify the results. Because a "standard surface" was analyzed in most cases, there were no interpretive problems. The spall results also have five qualifiers (table II). The biggest problem here was in possible cross-spall—particularly from samples tested in adjacent tubes for a given run. Some of these problems are discussed in references 4 and 7.

Three major types of oxide scaling product are formed during oxidation (table III). First, there are the various discrete oxides such as the protective Al_2O_3 and Cr_2O_3, spall inhibitors like Y_2O_3 and ZrO_2, and minor constituent oxides including MoO_2 and $CoWO_4$. Second, there is a class of solid-solution cubic oxides termed spinels. Finally, there is a rutile/tri-rutile tetragonal oxide consisting of Ti and the refractory metals Ta, Cb, W, and Mo. The 21 discrete oxides listed in the first part of table III range from the commonly found Cr_2O_3, NiO, and Al_2O_3 to the less common $CoMoO_4$.

The cubic oxides, termed spinels, are listed by their lattice parameter values in angstroms. Generally, the three lower values (8.05, 8.10, and 8.15 Å) denote aluminate spinels like $NiAl_2O_4$. Spinels with values ranging from 8.25 to 8.40 Å are usually chromites like $NiCr_2O_4$. Spinels with values close to 8.50 Å are usually spinels with high manganese content.

A third type of oxide has a tetragonal structure containing titanium or refractory metals and is classed as rutile/tri-rutile. This general category of oxides includes tapiolite (ref. 3) with a general composition of Ni, Fe, Co(Nb, Ta, Mo, W)O_2; rutiles such as TiO_2, TaO_2, $AlTaO_4$, $CrTaO_4$, and $CrNbO_4$; and tri-rutiles with a general composition of Ni, Co, Fe(Ta, NB)O_4. These subcategories are difficult to distinguish, especially in small amounts, and here they are differentiated by the lattice spacing (i.e., d-value of the (110) plane). In addition, there may be occasional diffraction lines that cannot be associated with one of these three phases. The d-values of up to four diffraction lines can be listed in order of decreasing intensity.

The test data are presented in alloy alphabetical order, first for the nickel-base and then for the cobalt-base systems. The individual alloy data are shown from high to low temperatures and from short to long cycle times (i.e., assumed decreasing order of test severity) and the sequence from lowest to highest numbered runs.

Comments on the Data

The induction-melted cast test specimens were of several different types. They are classified as shown in table IV.

The following tests might be possible outliers since the results appeared anomalous when compared with other results for the same alloy. However, they were included because no reason could be found to reject them.

(1) Run 336-4 on page 49 for B-1900 at 1100 °C
(2) Run 324-4 on page 99 for MAR-M-211 at 1100 °C
(3) Run 078-3 on page 105 for NASA-TRW-VI-A at 1150 °C

The TAZ-8A alloy results fall into two groupings. The first grouping represents experimental heats, whereas the data on pages 136 and 140 were for samples from a remelted commercial ingot.

The variability in the IN-100 alloy results has been discussed previously in reference 6.

References

1. Barrett, C.A.; and Evans, E.B.: Cyclic Oxidation Evaluation—Approaching Application Conditions. NASA TM X-68252, 1973.
2. Spera, D.A.; and Grisaffe, S.J.: Life Prediction of Turbine Components: On-Going Studies at Lewis Research Center. NASA TM X-2664, 1973.
3. Barrett, C.A.; Santoro, G.J.; and Lowell, C.E.: Isothermal and Cyclic Oxidation at 1000 and 1100 °C of Four Nickel-Base Alloys: NASA-TRW-VI, B-1900, 713C, and 738X. NASA TN D-7484, 1973.
4. Barrett, C.A.; and Lowell, C.E.: Comparison of Isothermal and Cyclic Oxidation Behavior of Twenty-Five Commercial Sheet Alloys at 1150 °C. Oxid. Met., vol. 9, no. 4, Aug. 1975, pp. 307-355.
5. Barrett, C.A.: 10 000-Hour Cyclic Oxidation Behavior at 815 °C (1500 °F) of 33 High-Temperature Alloys. Environmental Degradation of Engineering Materials, M.R. Louthan, Jr., and R.P. McNitt, eds., Virginia Polytechnic Institute and State University, Blacksburg, VA., 1978, pp. 319-327.
6. Barrett, C.A.; Johnston, J.R.; and Sanders, W.A.: Static and Dynamic Cyclic Oxidation of 12 Nickel-, Cobalt-, and Iron-Base High-Temperature Alloys. Oxid. Met., vol. 12, no. 4, Aug. 1978, pp. 343-377.
7. Barrett, C.A.; and Lowell, C.E.: High Temperature Cyclic Oxidation Furnace Testing at NASA Lewis Research Center. Journal of Testing and Evaluation, JTEVA, vol. 10, no. 6, Nov. 1982, pp. 273-278. (Also NASA TM-81773.)

TABLE I.—TEST ALLOYS

Code	Alloy
Nickel-base, cast γ/γ'	
02-04-01	B-1900
02	B-1900 + Hf
40	DS IN-100
10	DS MAR-M-200 + Hf
39	DS NX-188
42	DS TAZ-8A
41	DS WAZ-20
03	IN-100
04	IN-713C
05	IN-738
06	IN-792
07	IN-792 + Hf
31	IN-939
08	MAR-M-200
09	MAR-M-200 + Hf
11	MAR-M-211
12	MAR-M-246
26	MAR-M-247
13	MAR-M-421
21	NASA-TRW-VI-A
27	NX-188
15	René 77
25	René 80
16	René 120
17	René 125
19	TAZ-8A
20	TRW-1910
32	TRW-R
43	U-700
24	WAZ-20

Code	Alloy
Nickel-base, hot-worked γ/γ'	
02-13-01	Alloy 625
02	Alloy 718
03	Astroloy
04	Nimonic 115
05	R-235
06	René 41
07	René 77
08	U-500
09	U-520
10	U-700
38	U-700(PM/HIP)
11	U-710
12	U-720
13	Waspaloy
Cobalt-base, cast (turbine) alloys	
03-02-03	MAR-M-509
02	WI-52
01	X-40

TABLE II.—NATURE OF X-RAY DIFFRACTION RESULTS

Specimen surface	Scale spall
Standard normal surface	Collected spall
Surface distorted	Probable cross-spall
Sample consumed	No spall observed
Sample lost in furnace	Spall lost
Surface growth	No spall available
Selected areas	
Poor surface (round and flexed)	
Scraped	
Second surface phase	

TABLE III.—OBSERVED OXIDES FORMED IN CYCLIC OXIDATION OF Fe-Ni-, AND Co-BASE ALLOYS AT HIGH TEMPERATURES AS DETERMINED BY X-RAY DIFFRACTION

Type	Composition	Comments
Oxide	Cr_2O_3	Protective
	Al_2O_3	Protective
	Fe_2O_3	Nonprotective
	NiO	↓
	CoO	
	(Ni,Co)O	
	Y_2O_3	Spall inhibitor } Protective
	ZrO_2	Spall inhibitor
	SiO_2	Spall inhibitor
	ThO_2	Spall inhibitor
	HfO_2	Spall inhibitor
	Mn_2O_3	---
	MoO_2	---
	Ni(W, Mo)O_4	JCPDS-15-755 or 16-291
	Ni(W, Mo)O_4	JCPDS-18-879
	$CoMoO_4$	JCPDS-25-1434
	$CoMoO_4$	JCPDS-21-868
	$CoWO_4$	JCPDS-15-867
	$3Y_2O_3$-$5Al_2O_3$	JCPDS-8-178
	$3Y_2O_3$-$5Al_2O_3$	JCPDS-9-310
	(Ni, Co, Fe)TiO_3	JCPDS-17-617 or 15-866 or 29-733
	$Cr_{0.12}T_{0.78}O_{1.74}$	---
	Al_2TiO_5	---
	Al(Ta, Cb)O_4	---
	(Ni, Co)TiO_3	JCPDS 17-617, 15-866
Oxide spinels	MeM_2O_4 (cubic) denoted by lattice parameter, a_o: 8.05, 8.10, 8.15 Å—Aluminate spinels 8.20 to 8.40 Å—Chromite spinels 8.45 to 8.50 Å Manganate spinels	Where Me is Fe, Ni, or Co and M is Fe, Cr, Al, or Mn
Rutile/tri-rutile	Tetragonal denoted by lattice spacing, d, on (110): 3.25 to 3.27 Å—TiO_2 3.27 to 3.34 Å—Cr (refractory metal)O_4 3.34 to 3.36 Å—Ni, Fe, Co (refractory metal)$_2O_6$ or TaO_2	Where refractory metal is Ta, Cb, W, Mo

TABLE IV.—INDUCTION-MELTED CAST TEST SPECIMEN TYPES

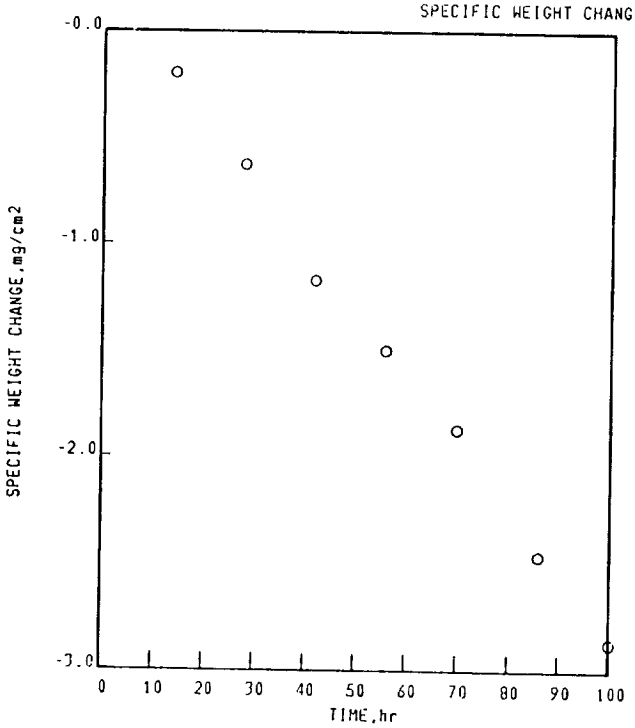
Specimen type		Run-position number
Master ingot recast as 4- by 1- by 0.25-in.-thick bars, heat treated and sectioned into four 1- by 1- by 0.25-in.-thick samples with a 0.125-in.-diam hanger hole, with all sides ground to remove 0.01 in., all sides glass bead blasted		001-1 to 001-6 002-1 to 002-6 003-1 to 003-6 004-1 to 004-6 005-1 to 005-6 006-1 to 006-6 007-1 to 007-6 008-1 to 008-6 009-1 to 009-6 010-1 to 010-6 041-1 to 041-4 078-1, 078-2 078-3, 078-6 130-4, 130-5 221-5
Master ingot recast standard Mach 0.3 burner rig bar with shank 2-in.-long teardrop cross section, 0.5 in. across	2-in.-long cross section removed from shank with 0.125-in.-diam hanger hole	127-1, 127-2
	2-in.-long section, cut into 0.125-in.-thick samples with 0.125-in.-diam hanger hole	095-1 to 095-6 096-1 to 096-6 098-1 to 098-6 104-1, 104-2 120-1, 120-2 127-5, 127-6 128-1 to 128-6 131-4, 131-5 140-4, 140-5 146-3, 146-5 151-1, 151-2
Master ingot heat-cast into small ingots and machined into samples 0.4 to 0.5 by 0.9 in. long with 0.125-in.-diam hanger hole, ground to 0.090-in. thickness		041-6 108-3 to 108-6 232-3, 232-6

Specimen type		Run-position number
Master ingot recast as 1- by 2- by 0.100-in.-thick leafs cut to 0.4 to 0.5 by 0.9 in. long with 0.125-in.-diam hanger hole	As-cast thickness	99-1, 99-2 101-3 to 101-6 102-1 to 102-6 105-1 to 105-6 107-4, 107-5 115-3, 115-6 127-3, 127-4 139-1 to 139-6 190-6 204-5 221-1
	Ground to 0.090-in. thickness	123-1, 123-2, 123-5 129-3, 129-4, 129-6 130-3, 130-6 186-6 190-4, 190-5 204-3, 204-4 225-1 to 225-6 231-5 238-5 276-1 310-1 to 310-5 321-1 to 321-6 322-1 to 322-4 323-2 to 323-5 324-1 to 324-6 325-1 to 325-4 326-2 to 326-5 327-1, 327-3 328-1, 328-3 336-4, 336-5 337-4, 337-5
	Ground to 0.045-in. thickness	123-3, 123-4, 123-6 129-1, 129-2, 129-5 130-1, 130-2
Master ingot recast as 2-in.-long by 0.240-in.-diam. tensile samples, heat treated, with 0.125-in.-diam hanger hole		103-1 to 103-7

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-041-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
14.00	-0.20
28.00	-0.63
42.00	-1.18
56.00	-1.50
70.00	-1.87
86.00	-2.47
100.00	-2.87

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-041-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.

UNKNOWN LINES, d VALUES
2.57A.
3.29A.
3.52A.

FACE CENTERED CUBIC MATRIX

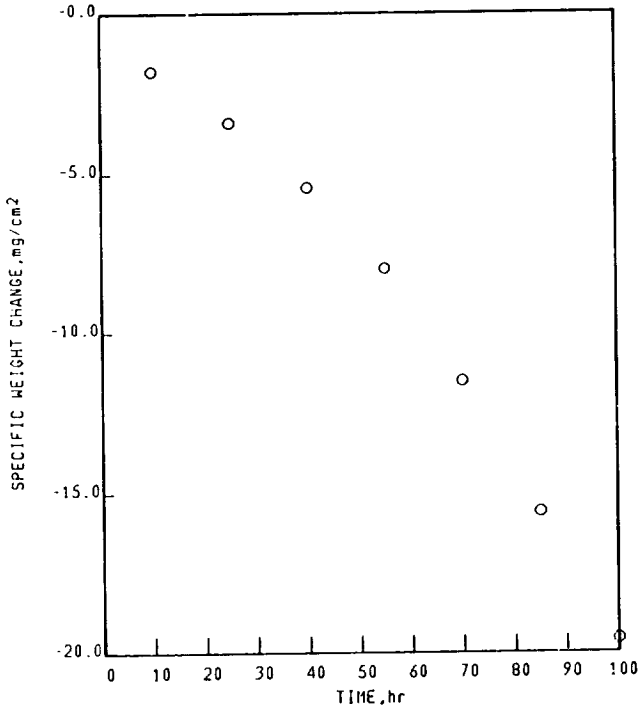
SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.20A.
Cr_2O_3

UNKNOWN LINES, d VALUES
3.26A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-078-2

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 6.480mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
10.00	-1.82
25.00	-3.43
40.00	-5.45
55.00	-8.00
70.00	-11.54
85.00	-15.60
100.00	-19.59

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-078-2

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 6.480mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
TRI(RUTILE), d(110)≤3.30A.
SPINEL, a_0=8.10A.
NiO
Al_2O_3

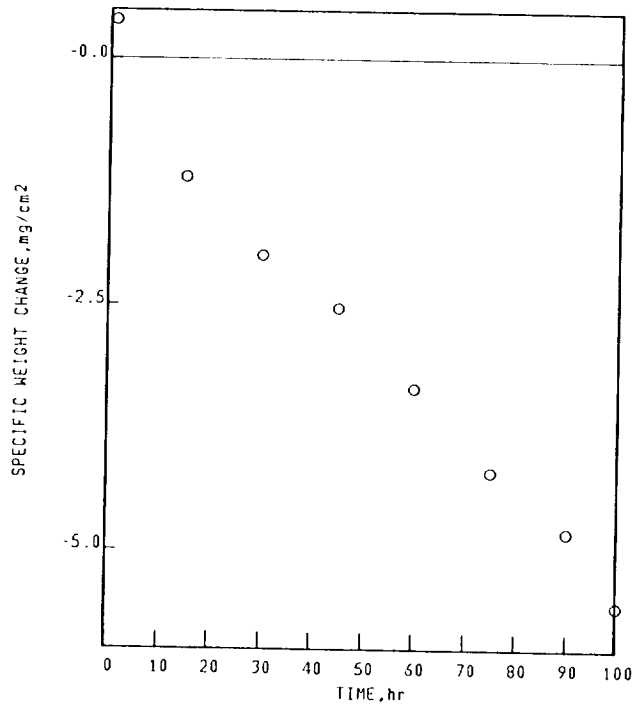
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE), d(110)≤3.30A.
TRI(RUTILE), d(110)≤3.30A.
Al_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-095-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 3.218mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.39
15.00	-1.21
30.00	-1.99
45.00	-2.53
60.00	-3.35
75.00	-4.20
90.00	-4.81
100.00	-5.56

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-095-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 3.218mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.15A.
NiO

FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.
SPINEL, a_0=8.15A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-095-2

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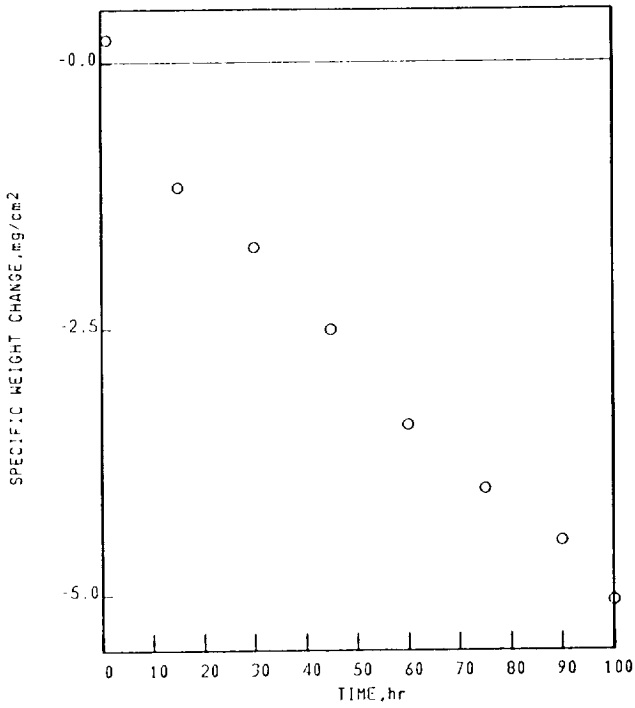
SPECIFIC WEIGHT CHANGE DATA

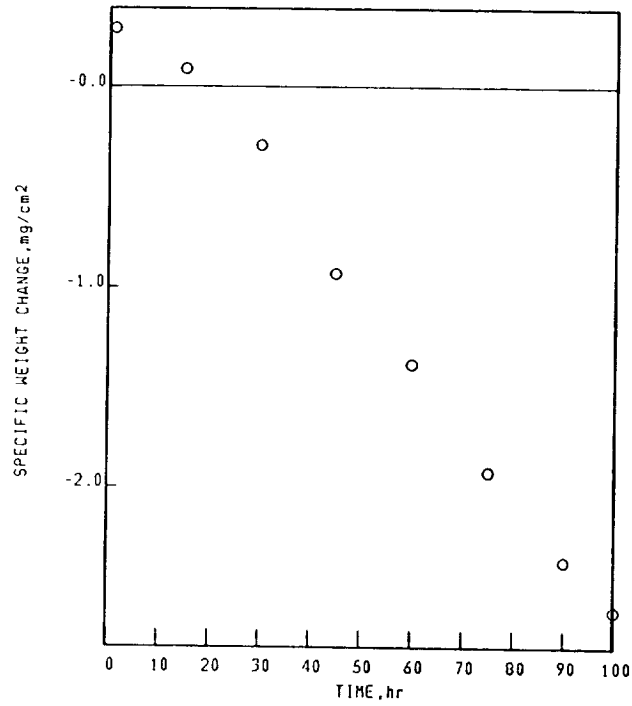


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.21
15.00	-1.17
30.00	-1.73
45.00	-2.51
60.00	-3.39
75.00	-3.99
90.00	-4.49
100.00	-5.05

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-101-3

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.732mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



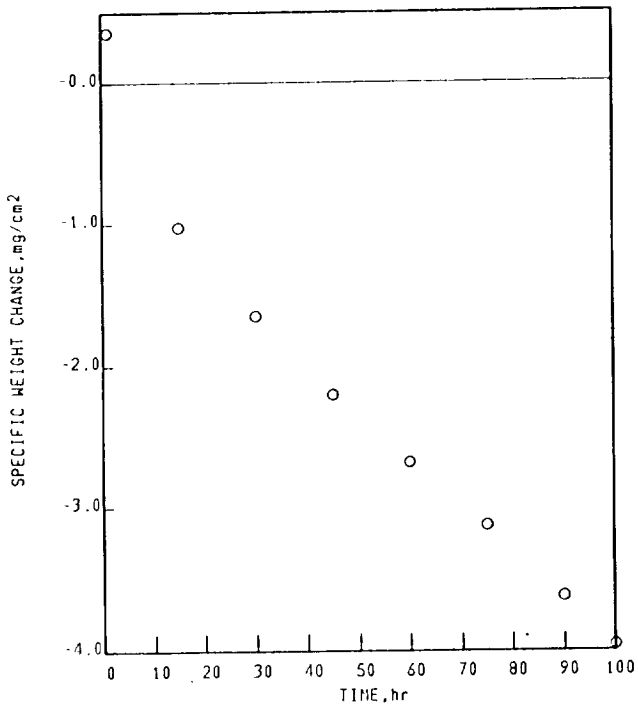
TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.29
15.00	0.09
30.00	-0.29
45.00	-0.93
60.00	-1.39
75.00	-1.92
90.00	-2.37
100.00	-2.62

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-101-6

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.738mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.35
15.00	-1.03
30.00	-1.65
45.00	-2.20
60.00	-2.69
75.00	-3.13
90.00	-3.62
100.00	-3.97



Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-101-6

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.738mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
NiO
Al_2O_3
TRI(RUTILE),d(110)<3.30A.
SPINEL, a_0=8.10A.

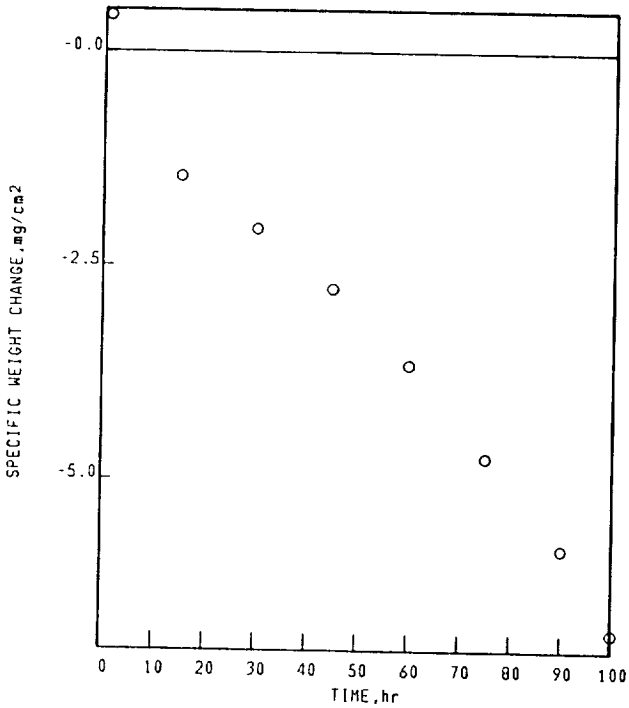
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
Cr_2O_3
SPINEL, a_0=8.35A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-107-4

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.741mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

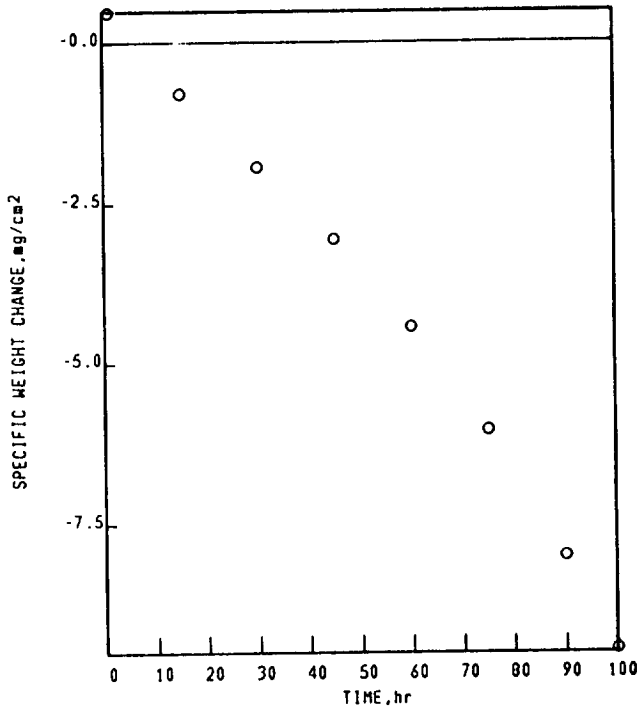


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.42
15.00	-1.45
30.00	-2.06
45.00	-2.77
60.00	-3.67
75.00	-4.73
90.00	-5.80
100.00	-6.80

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-107-5

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.710mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.47
15.00	-0.79
30.00	-1.92
45.00	-3.06
60.00	-4.43
75.00	-6.03
90.00	-8.00
100.00	-9.45

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-107-5

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.710mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3
SPINEL, a_0=8.15A.
NiO

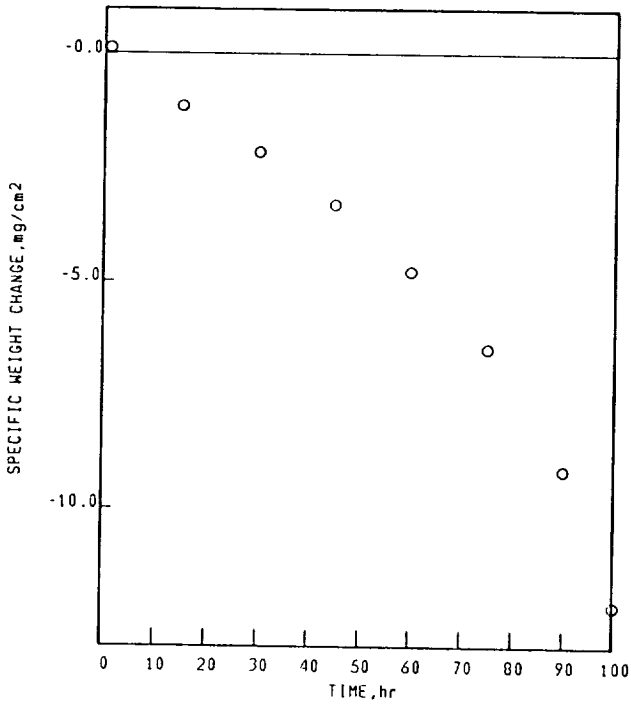
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)≤3.30A.
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.10A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-123-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.283mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

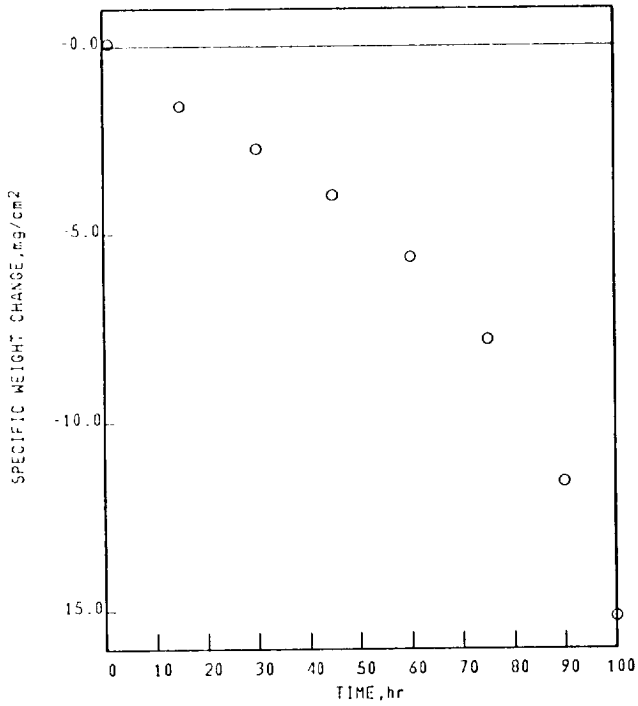


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.11
15.00	-1.17
30.00	-2.18
45.00	-3.34
60.00	-4.78
75.00	-6.48
90.00	-9.15
100.00	-12.11

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-123-2

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.285mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

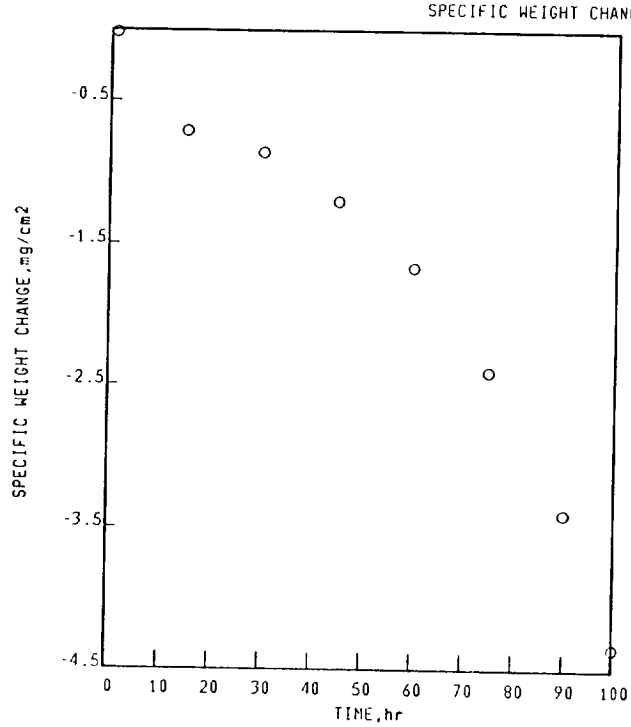


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.07
15.00	-1.59
30.00	-2.73
45.00	-3.98
60.00	-5.63
75.00	-7.80
90.00	-11.59
100.00	-15.16

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-123-4

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 1.142mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	-0.02
15.00	-0.72
30.00	-0.87
45.00	-1.20
60.00	-1.67
75.00	-2.41
90.00	-3.40
100.00	-4.35

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-123-4

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 1.142mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.25A.

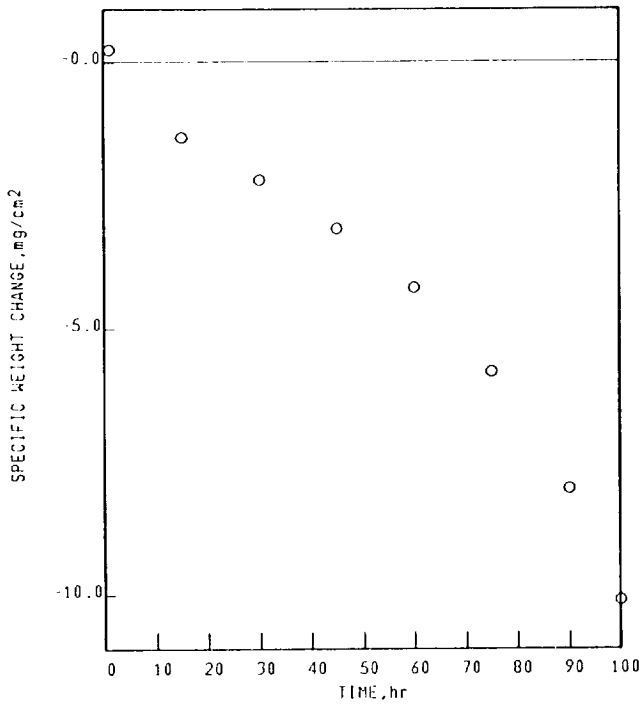
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
NO SIGNIFICANT SPALL OBSERVED

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-123-5

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.288mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.23
15.00	-1.43
30.00	-2.22
45.00	-3.14
60.00	-4.24
75.00	-5.82
90.00	-8.02
100.00	-10.10

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-123-5

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.288mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.
NiO
SPINEL, a_0=8.25A.
Cr_2O_3

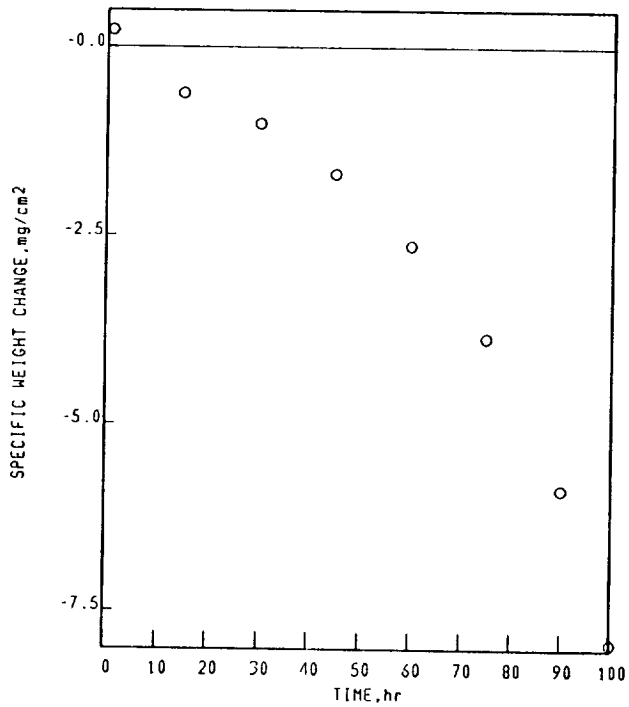
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.30A.
SPINEL, a_0=8.05A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-123-6

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 1.141mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

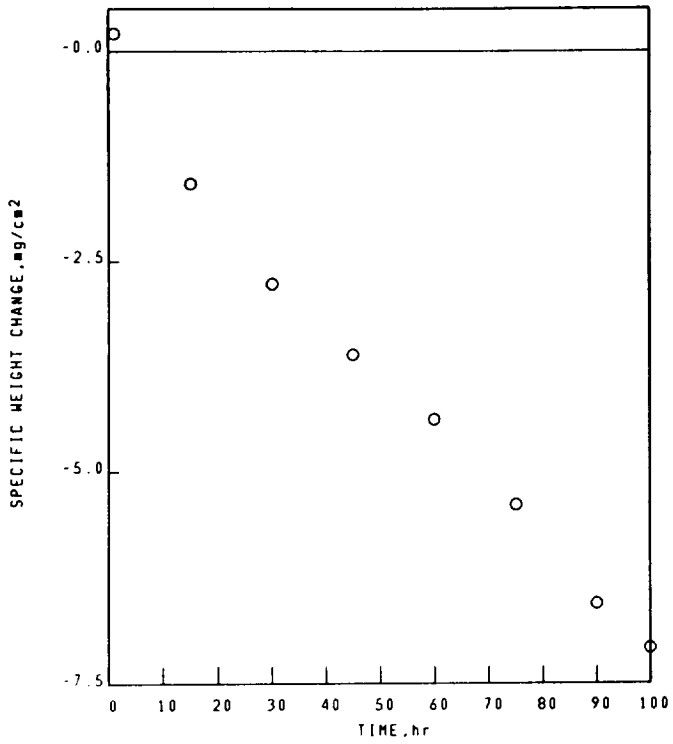


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.22
15.00	-0.60
30.00	-1.00
45.00	-1.67
60.00	-2.64
75.00	-3.86
90.00	-5.87
100.00	-7.93

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-128-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 3.302mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

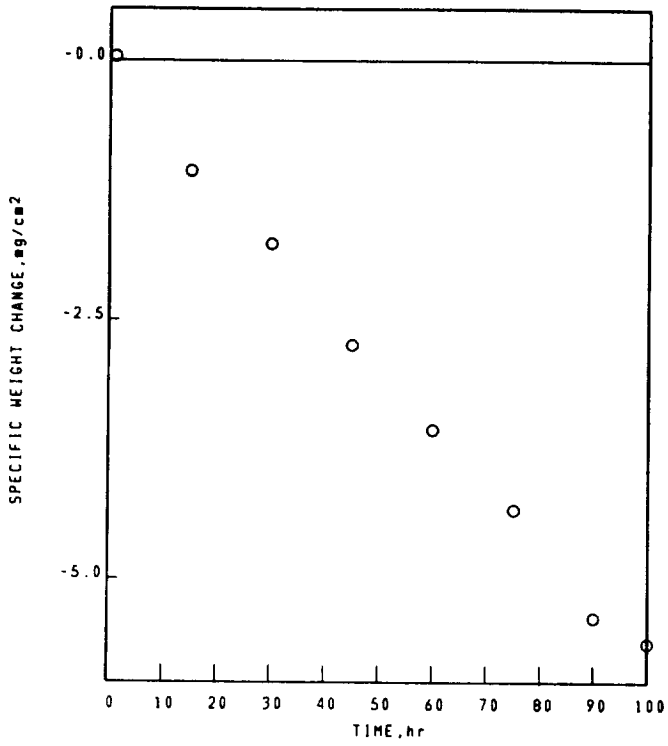


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.21
15.00	-1.58
30.00	-2.77
45.00	-3.61
60.00	-4.38
75.00	-5.40
90.00	-6.55
100.00	-7.08

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-128-2

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 3.302mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

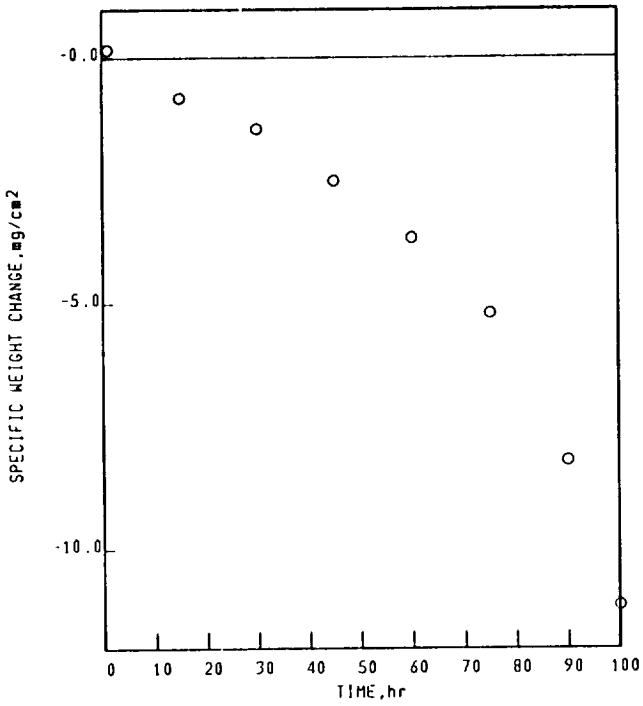


TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.04
15.00	-1.05
30.00	-1.76
45.00	-2.74
60.00	-3.55
75.00	-4.32
90.00	-5.38
100.00	-5.62

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-130-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 1.140mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

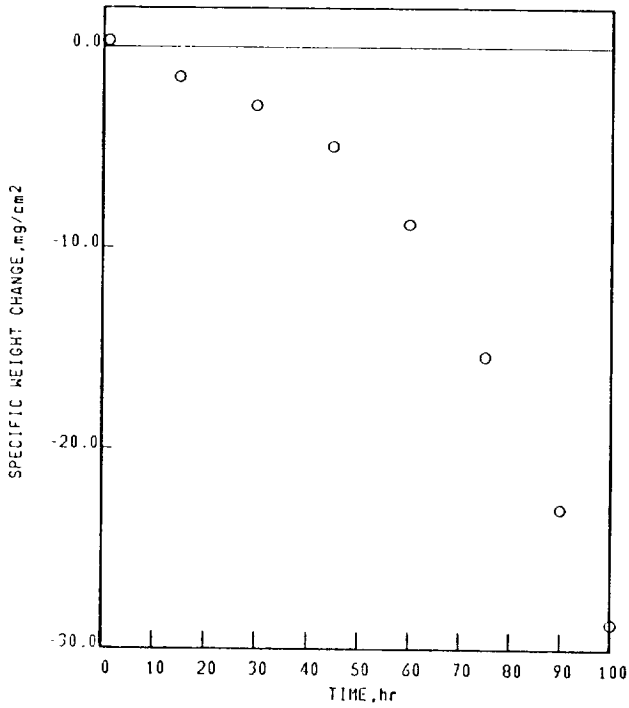


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.16
15.00	-0.82
30.00	-1.46
45.00	-2.52
60.00	-3.67
75.00	-5.20
90.00	-8.22
100.00	-11.14

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-130-2

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 1.140mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.30
15.00	-1.45
30.00	-2.86
45.00	-4.90
60.00	-8.83
75.00	-15.40
90.00	-23.01
100.00	-28.76

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-130-2

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 1.140mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
SPINEL, a_0=8.25A.
NiO
TRI(RUTILE),d(110)≤3.30A.

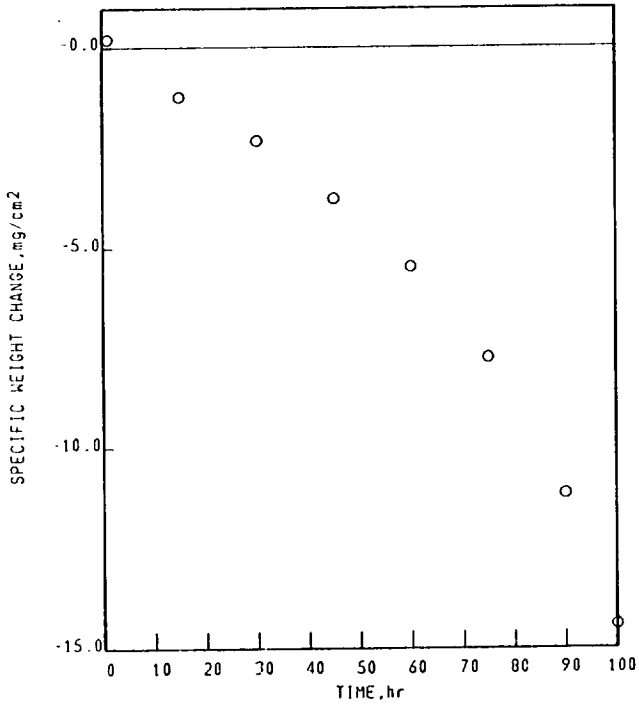
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.05A.
SPINEL, a_0=8.25A.
ZrO_2

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-130-3

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.285mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

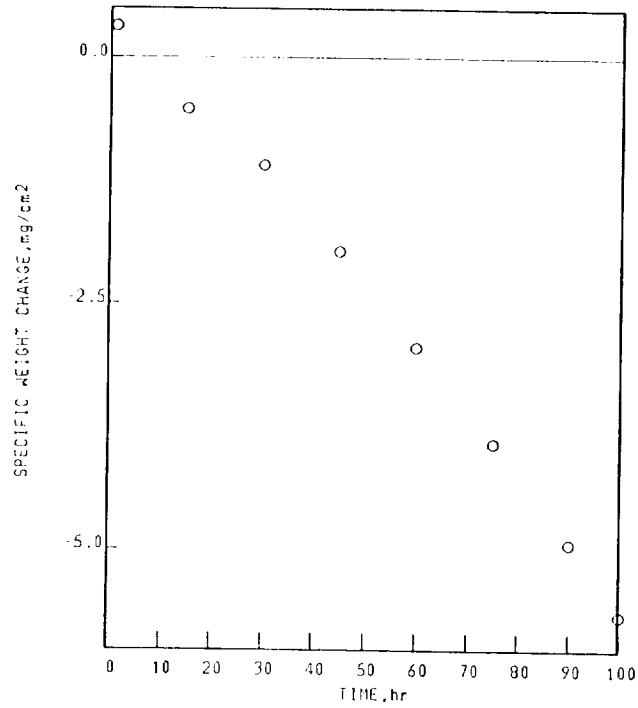


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.21
15.00	-1.25
30.00	-2.34
45.00	-3.76
60.00	-5.48
75.00	-7.76
90.00	-11.14
100.00	-14.43

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-130-4

B 1900 1150°C 1.00hr CYCLES 100.00hr TEST 6.505mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

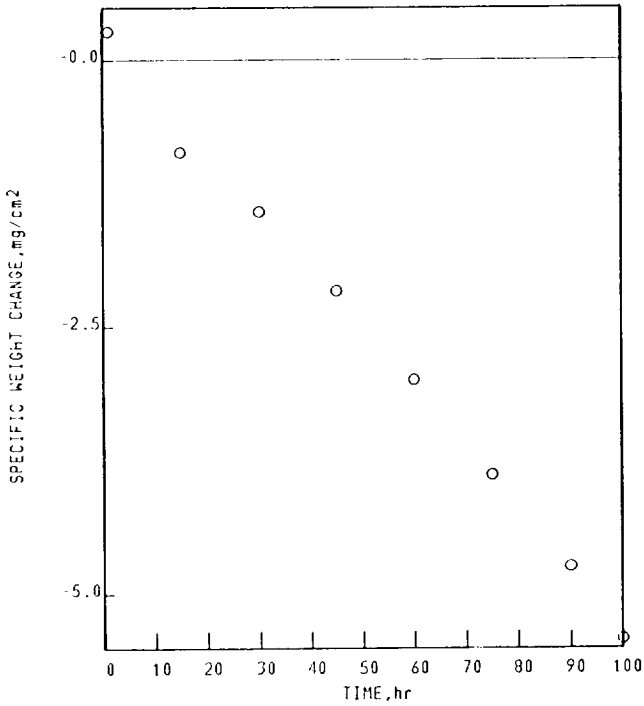


TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.31
15.00	-0.52
30.00	-1.10
45.00	-1.98
60.00	-2.94
75.00	-3.91
90.00	-4.93
100.00	-5.66

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-130-S

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 6.511mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.27
15.00	-0.85
30.00	-1.41
45.00	-2.16
60.00	-2.99
75.00	-3.88
90.00	-4.74
100.00	-5.42

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-130-S

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 6.511mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
TRI(RUTILE),d(110)≤3.30A.
NiO

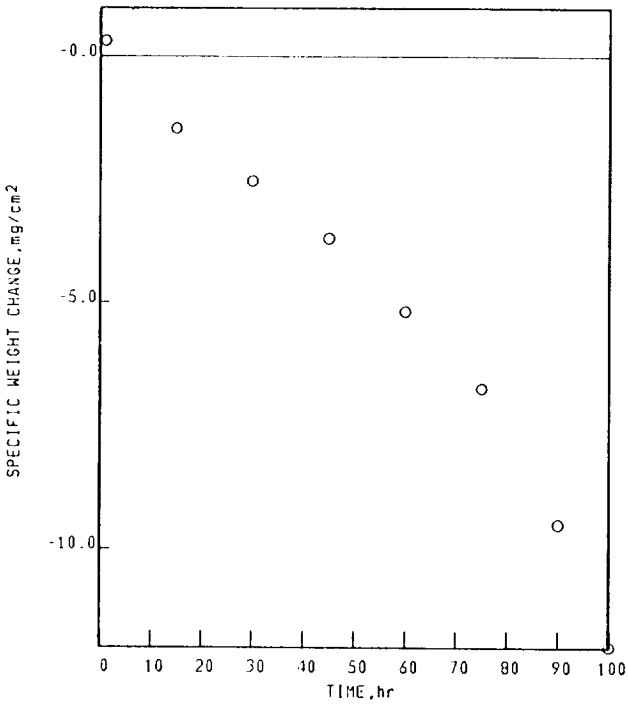
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
SPINEL, a_0=8.05A.
NiO
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04 001-130-6

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.290mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.31
15.00	-1.48
30.00	-2.55
45.00	-3.70
60.00	-5.17
75.00	-6.75
90.00	-9.50
100.00	-11.99

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-130 6

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.290mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
TRI(RUTILE),d(110)≤3.30A.
NiO
SPINEL, a_0=8.25A.

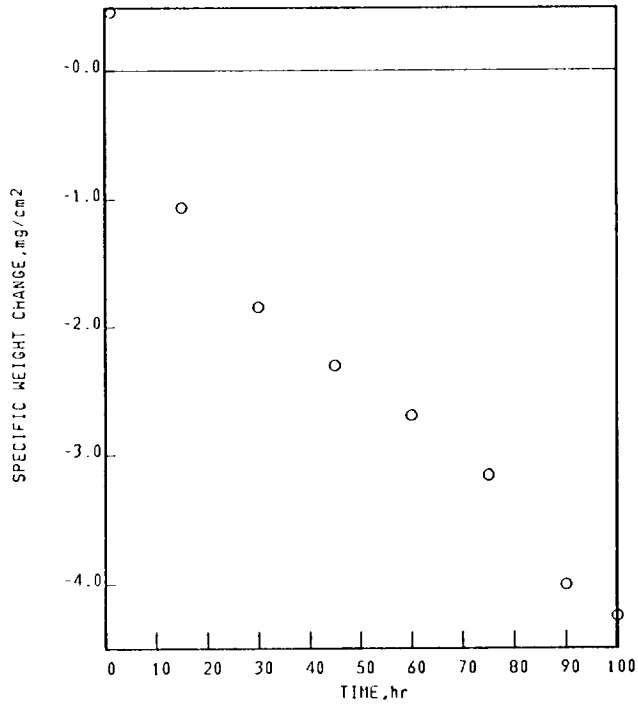
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.05A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-146-5

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

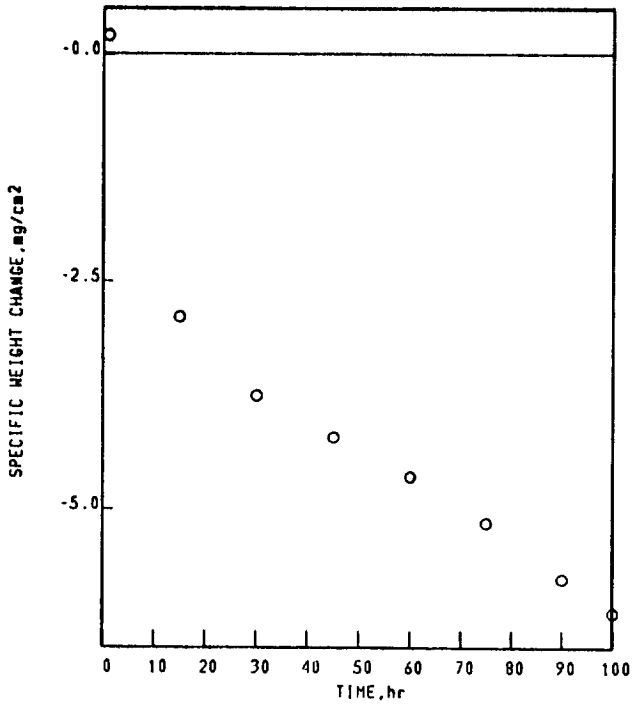


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.46
15.00	-1.06
30.00	-1.84
45.00	-2.30
60.00	-2.69
75.00	-3.15
90.00	-4.00
100.00	-4.25

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-204-4

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.321mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.20
15.00	-2.89
30.00	-3.75
45.00	-4.21
60.00	-4.64
75.00	-5.15
90.00	-5.76
100.00	-6.13

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-204-4

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.321mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
Al_2O_3
SPINEL, a_0=8.15A.

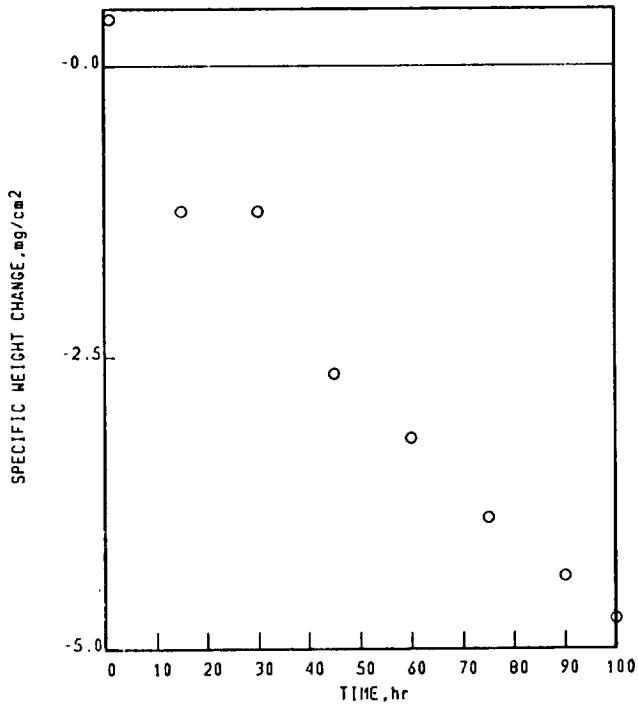
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)>3.30A.
SPINEL, a_0=8.20A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-221-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.700mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.41
15.00	-1.24
30.00	-1.24
45.00	-2.65
60.00	-3.19
75.00	-3.87
90.00	-4.38
100.00	-4.75

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-221-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.700mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

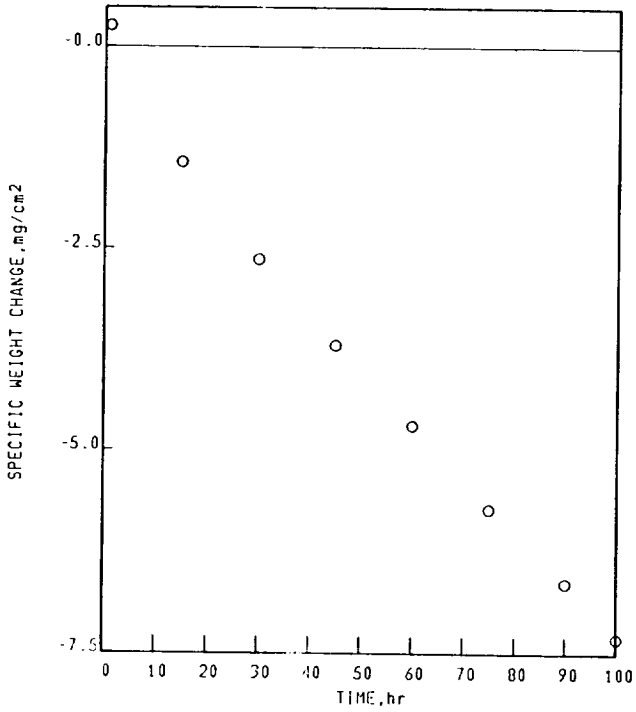
SPALL
100 hr
COLLECTED SPALL
TRI(RUTILE),d(110)≤3.30A.
NiO
SPINEL, a_0=8.05A.
SPINEL, a_0=8.25A.
Al_2O_3

UNKNOWN LINES, d VALUES
2.64A.
3.60A.
4.38A.
5.09A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-221-S

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 6.353mm THICK +0.SI, STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.26
15.00	-1.44
30.00	-2.63
45.00	-3.70
60.00	-4.69
75.00	-5.72
90.00	-6.63
100.00	-7.31

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-221-S

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 6.353mm THICK +0.SI, STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.20A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

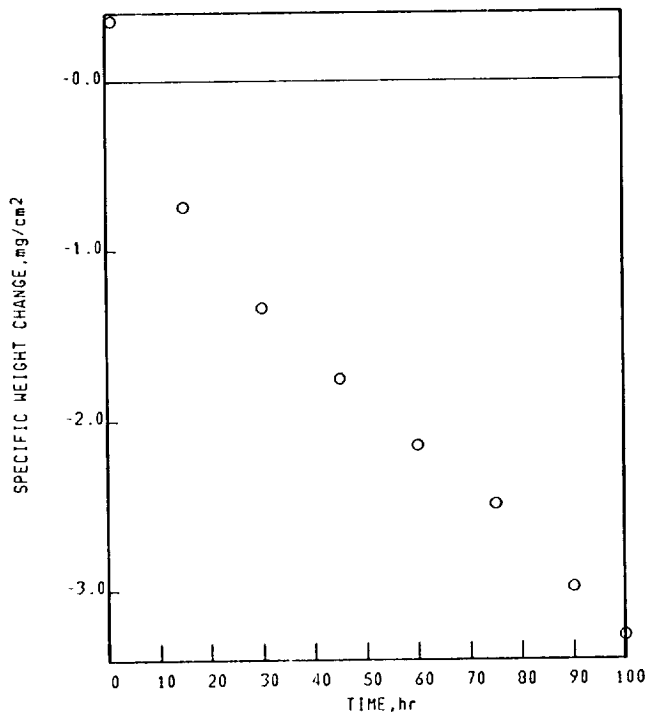
SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.
SPINEL, a_0=8.10A.
TRI(RUTILE),d(110)>3.30A.
TRI(RUTILE),d(110)≤3.30A.

UNKNOWN LINES, d VALUES
5.05A.
2.65A.
4.39A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-328-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK STATIC AIR(SMP)

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.35
15.00	-0.74
30.00	-1.34
45.00	-1.75
60.00	-2.15
75.00	-2.49
90.00	-2.98
100.00	-3.27

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-328-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK STATIC AIR(SMP)

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.25A.

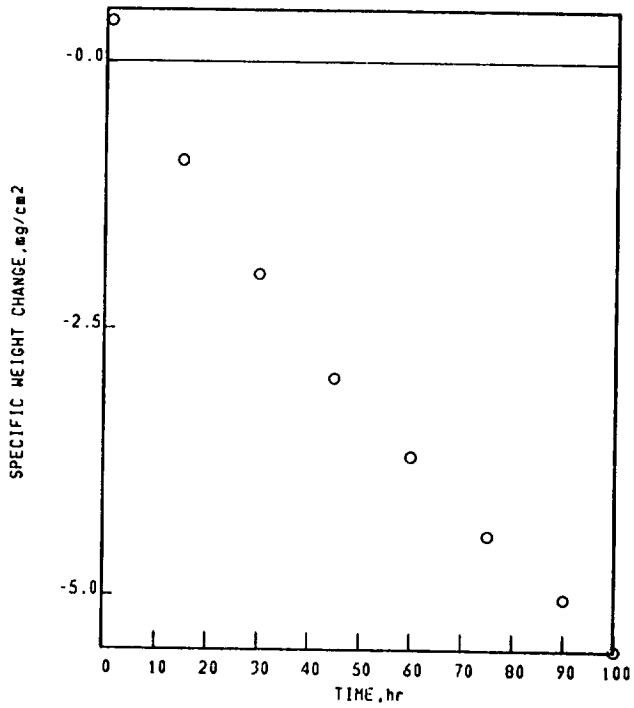
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
PROBABLE CROSS-SPALL
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
CoO
TRI(RUTILE),d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-321-2

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.334mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.38
15.00	-0.92
30.00	-1.98
45.00	-2.96
60.00	-3.69
75.00	-4.42
90.00	-5.02
100.00	-5.50

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-321-2

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.334mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
SPINEL, a_0=8.25A.
TRI(RUTILE), d(110)≤3.30A.

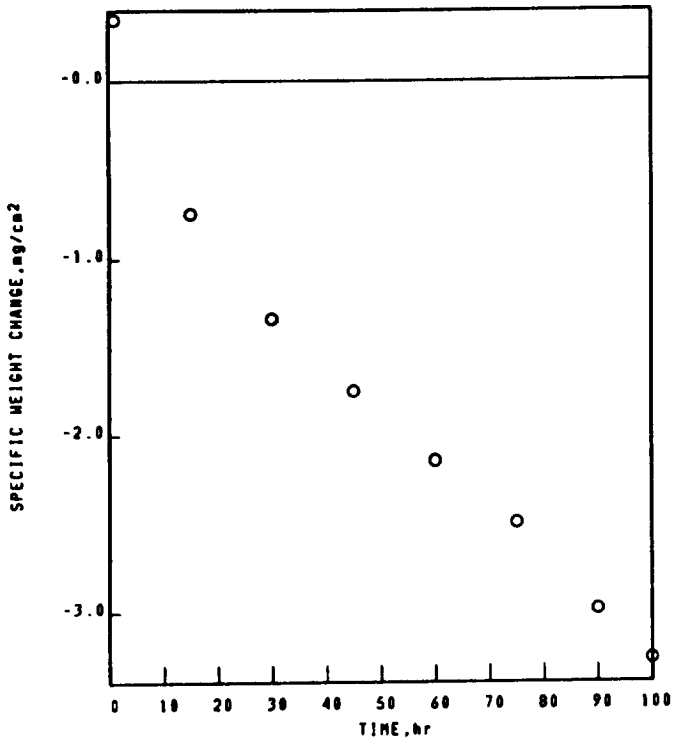
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.
SPINEL, a_0=8.05A.
TRI(RUTILE), d(110)>3.30A.
TRI(RUTILE), d(110)≤3.30A.
Cr_2O_3
Al_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-328-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.35
15.00	-0.74
30.00	-1.34
45.00	-1.75
60.00	-2.15
75.00	-2.49
90.00	-2.98
100.00	-3.27

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-328-1

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.25A.

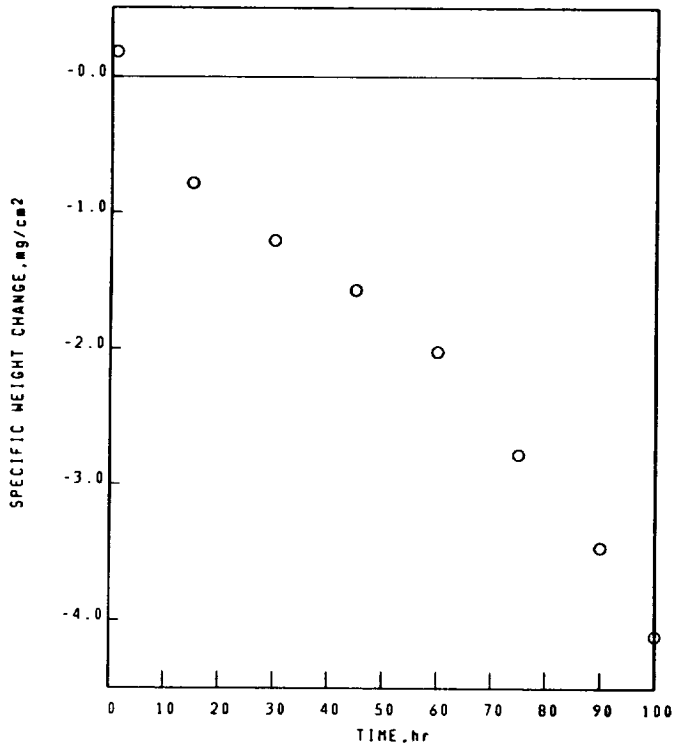
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
PROBABLE CROSS-SPALL
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
CoO
TRI(RUTILE),d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-337-4

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.18
15.00	-0.79
30.00	-1.21
45.00	-1.57
60.00	-2.02
75.00	-2.78
90.00	-3.47
100.00	-4.11

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-337-4

B-1900 1150°C 1.00hr CYCLES 100.00hr TEST 2.318mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE), d(110)≤3.30A.
SPINEL, a_0=8.25A.

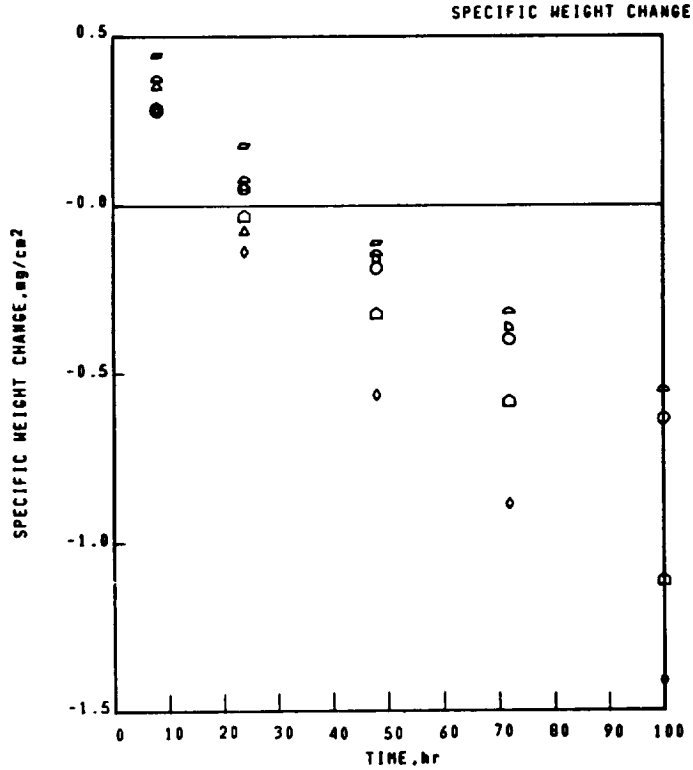
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
TRI(RUTILE), d(110)≤3.30A.
SPINEL, a_0=8.10A.
$Ni(W,Mo)O_4$ TYPE 1
Cr_2O_3
Al_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-002-6

B-1900 1100°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR(TM D-7484)

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
8.00	0.28
24.00	0.05
48.00	-0.19
72.00	-0.40
100.00	-0.64

TIME,hr	ΔW/A,mg/cm² 002-1
0.00	0.00
8.00	0.28

TIME,hr	ΔW/A,mg/cm² 002-2
0.00	0.00
8.00	0.35
24.00	-0.08

TIME,hr	ΔW/A,mg/cm² 002-3
0.00	0.00
8.00	0.44
24.00	0.10
48.00	-0.11

TIME,hr	ΔW/A,mg/cm² 002-4
0.00	0.00
8.00	0.28
24.00	0.06
48.00	-0.16
72.00	-0.37

TIME,hr	ΔW/A,mg/cm² 002-5
0.00	0.00
8.00	0.38
24.00	0.08
48.00	-0.14
72.00	-0.32
100.00	-0.55

TIME,hr	ΔW/A,mg/cm² 010-2
0.00	0.00
8.00	0.28
24.00	-0.14
48.00	-0.56
72.00	-0.89
100.00	-1.41

TIME,hr	ΔW/A,mg/cm² 010-3
0.00	0.00
8.00	0.29
24.00	-0.03
48.00	-0.32
72.00	-0.58
100.00	-1.11

X-RAY DIFFRACTION DATA

002-1

SURFACE
8 hr
STANDARD SURFACE
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

SPALL
8 hr
NO SIGNIFICANT SPALL OBSERVED

X-RAY DIFFRACTION DATA

002-5

SURFACE
100 hr
STANDARD SURFACE
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

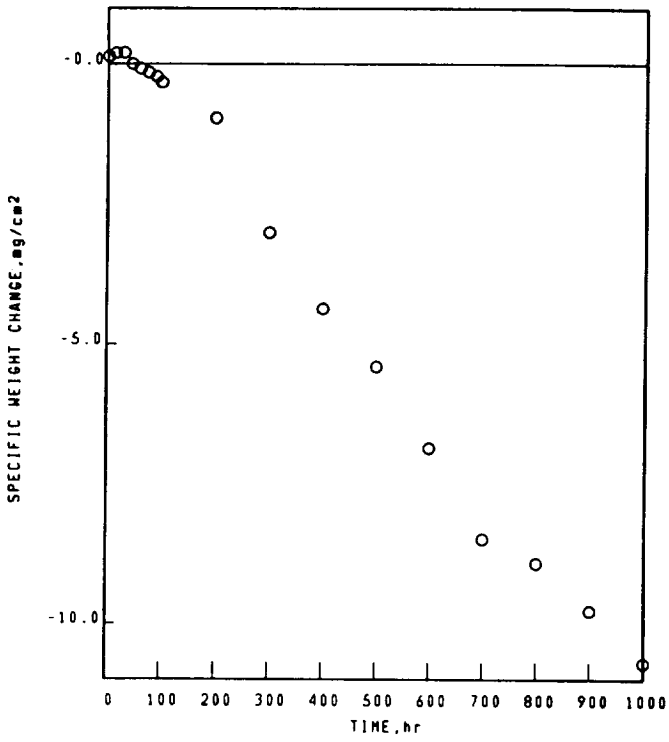
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
Al_2O_3
Ni IN SPALL
SPINEL, a_0=8.25A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-103-3

B-1900 1100°C 1.00hr CYCLES 1000.00hr TEST 6.240mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.14
15.00	0.20
30.00	0.20
45.00	0.00
60.00	-0.08
75.00	-0.15
90.00	-0.23
100.00	-0.33
200.00	-0.97
300.00	-3.00
400.00	-4.36
500.00	-5.40
600.00	-6.86
700.00	-8.47
800.00	-8.90
900.00	-9.76
1000.00	-10.71

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-103-3

B-1900 1100°C 1.00hr CYCLES 1000.00hr TEST 6.240mm THICK STATIC AIR

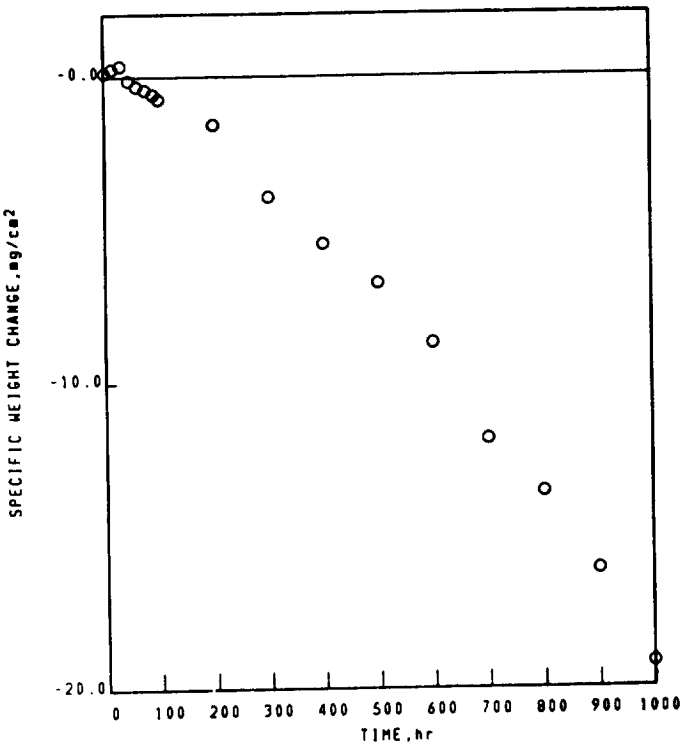
X-RAY DIFFRACTION DATA

SURFACE	SPALL
500 hr	500 hr
SURFACE NOT SATISFACTORY-NO XRD COLLECTED	SPALL
	NiO
	TRI(RUTILE),d(110)>3.30A.
	SPINEL, a_0=8.35A.
	TRI(RUTILE),d(110)≤3.30A.
600 hr	600 hr
SURFACE NOT SATISFACTORY-NO XRD COLLECTED	SPALL
	NiO
	TRI(RUTILE),d(110)≤3.30A.
	TRI(RUTILE),d(110)≤3.30A.
	SPINEL, a_0=8.05A.
	SPINEL, a_0=8.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-103-4

B-1900 1100°C 1.00hr CYCLES 1000.00hr TEST 6.240mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.14
15.00	0.26
30.00	0.36
45.00	-0.11
60.00	-0.31
75.00	-0.42
90.00	-0.57
100.00	-0.72
200.00	-1.56
300.00	-3.93
400.00	-5.48
500.00	-6.78
600.00	-8.73
700.00	-11.07
800.00	-13.61
900.00	-16.16
1000.00	-19.18

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-103-4

B-1900 1100°C 1.00hr CYCLES 1000.00hr TEST 6.240mm THICK STATIC AIR

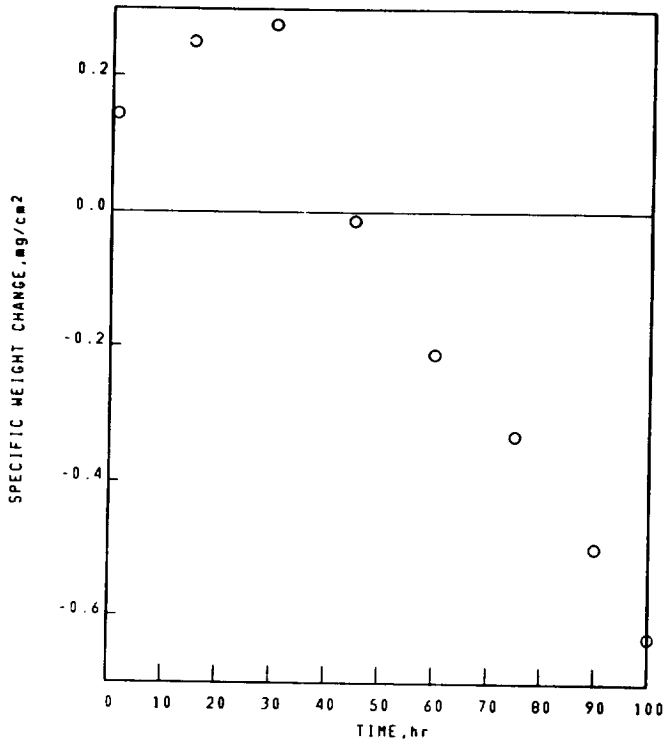
X-RAY DIFFRACTION DATA

SURFACE	SPALL
500 hr	500 hr
SURFACE NOT SATISFACTORY-NO XRD	COLLECTED SPALL
	NiO
	TRI(RUTILE),d(110)≤3.30A.
	TRI(RUTILE),d(110)≤3.30A.
	SPINEL, a_0=8.10A.
	SPINEL, a_0=8.25A.
600 hr	600 hr
SURFACE NOT SATISFACTORY-NO XRD	COLLECTED SPALL
	NiO
	TRI(RUTILE),d(110)>3.30A.
	TRI(RUTILE),d(110)≤3.30A.
	SPINEL, a_0=8.25A.
	SPINEL, a_0=8.05A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-103-5

B-1900 1100°C 1.00hr CYCLES 100.00hr TEST 6.240mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.14
15.00	0.25
30.00	0.28
45.00	-0.01
60.00	-0.21
75.00	-0.33
90.00	-0.50
100.00	-0.63

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-103-5

B-1900 1100°C 1.00hr CYCLES 100.00hr TEST 6.240mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
500 hr
SURFACE NOT SATISFACTORY-NO XRD COLLECTED SPALL

SPALL
500 hr
NiO
TRI(RUTILE), d(110)≤3.30A.

UNKNOWN LINES, d VALUES
1.46A.
1.43A.
1.60A.
3.14A.

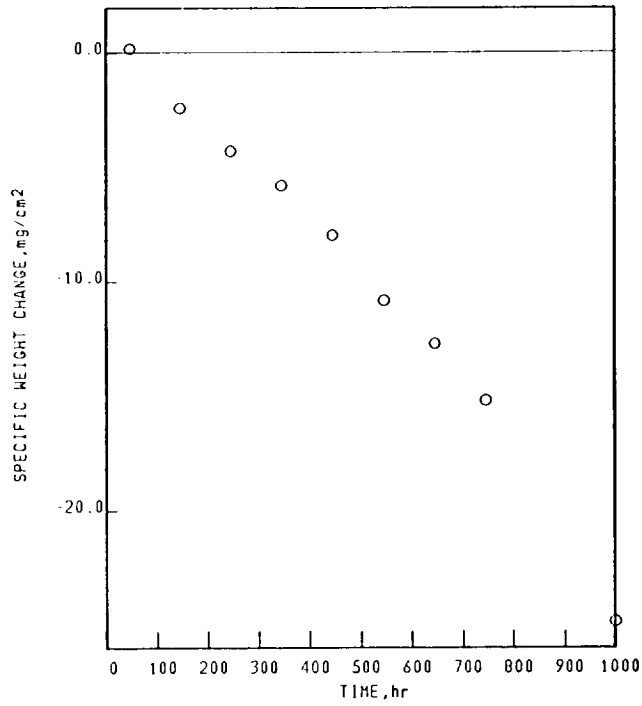
600 hr
SURFACE NOT SATISFACTORY-NO XRD COLLECTED SPALL

600 hr
NiO
TRI(RUTILE), d(110)>3.30A.
TRI(RUTILE), d(110)≤3.30A.
SPINEL, a_0=8.25A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-103-7

B-1900 1100°C 1.00hr CYCLES 1000.00hr TEST 6.240mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

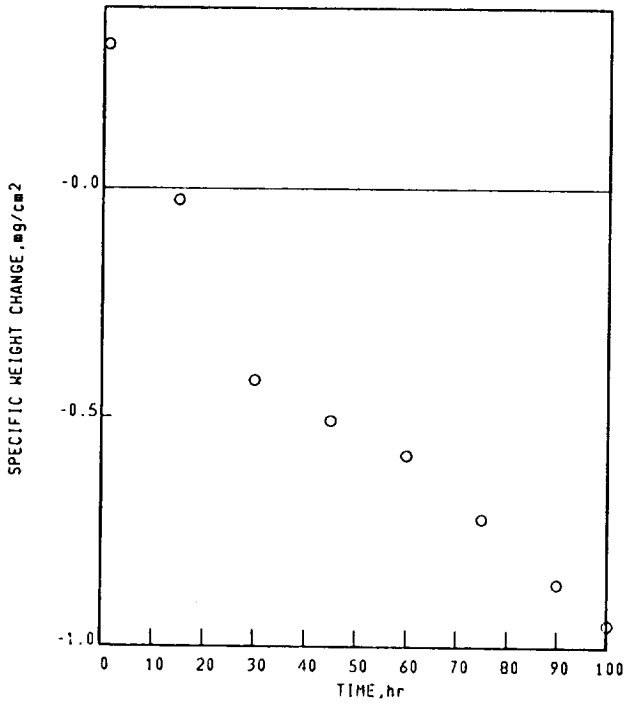


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
46.00	0.17
146.00	-2.43
246.00	-4.28
346.00	-5.77
446.00	-7.97
546.00	-10.84
646.00	-12.74
746.00	-15.22
1000.00	-24.88

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-115-3

B-1900 1100°C 1.00hr CYCLES 100.00hr TEST 2.773mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.32
15.00	-0.03
30.00	-0.42
45.00	-0.51
60.00	-0.58
75.00	-0.72
90.00	-0.86
100.00	-0.95

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-115-3

B-1900 1100°C 1.00hr CYCLES 100.00hr TEST 2.773mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
TRI(RUTILE), d(110)≤3.30A.
Al_2O_3

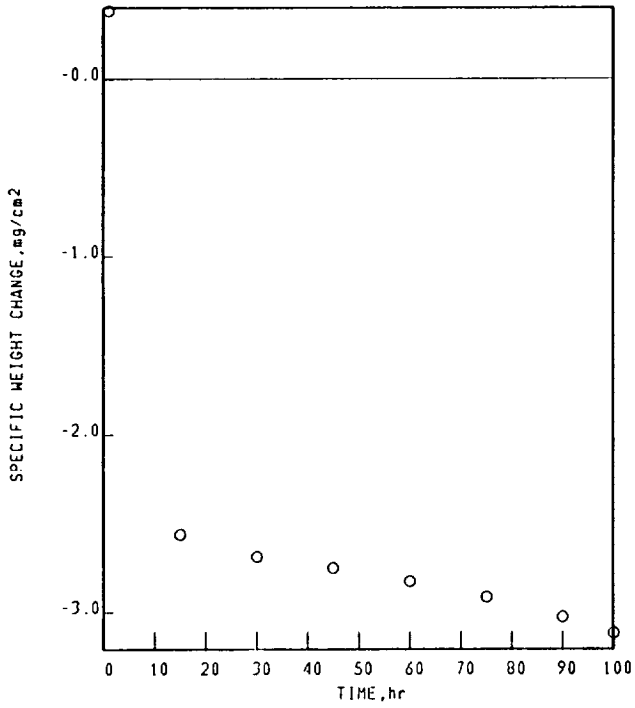
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
TRI(RUTILE), d(110)≤3.30A.
NiO
SPINEL, a_0=8.20A.
SPINEL, a_0=8.10A.
Al_2O_3
Cr_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-115-6

B-1900 1100°C 1.00hr CYCLES 100.00hr TEST 2.910mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

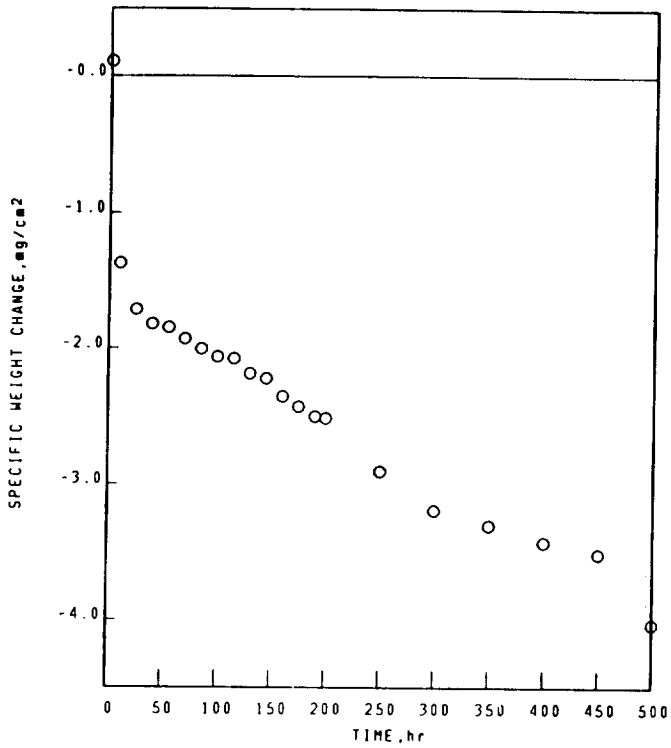


TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.38
15.00	-2.57
30.00	-2.69
45.00	-2.75
60.00	-2.83
75.00	-2.92
90.00	-3.03
100.00	-3.12

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-186-6

B-1900 1100°C 1.00hr CYCLES 500.00hr TEST 2.321mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.11
10.00	-1.37
25.00	-1.71
40.00	-1.82
55.00	-1.84
70.00	-1.93
85.00	-2.00
100.00	-2.06
115.00	-2.08
130.00	-2.19
145.00	-2.22
160.00	-2.36
175.00	-2.43
190.00	-2.50
200.00	-2.52
250.00	-2.91
300.00	-3.19
350.00	-3.30
400.00	-3.42
450.00	-3.50
500.00	-4.03

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-186-6

B-1900 1100°C 1.00hr CYCLES 500.00hr TEST 2.321mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE), d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

500 hr
STANDARD SURFACE
Al_2O_3
SPINEL, a_0=8.10A.
TRI(RUTILE), d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

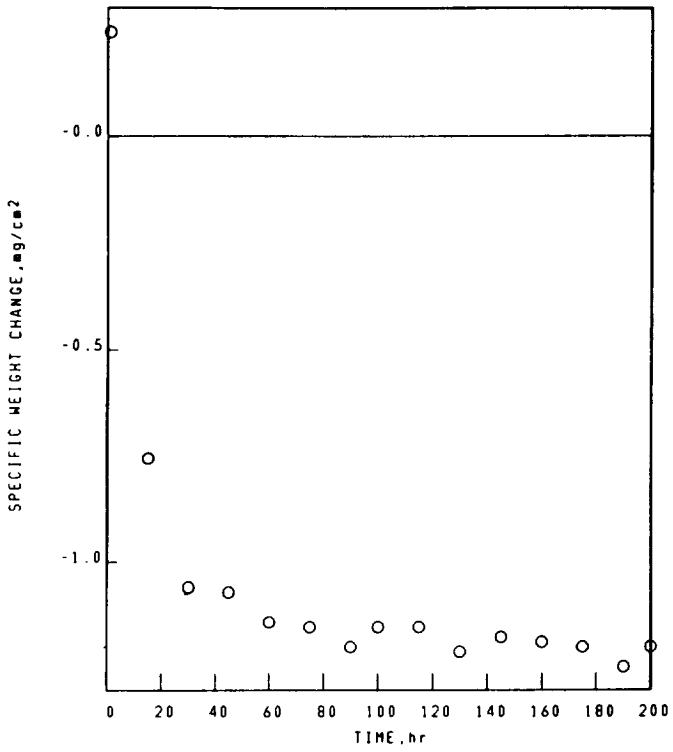
SPALL
200 hr
COLLECTED SPALL
Al_2O_3
NiO
SPINEL, a_0=8.35A.
TRI(RUTILE), d(110)≤3.30A.

500 hr
COLLECTED SPALL
TRI(RUTILE), d(110)≤3.30A.
TRI(RUTILE), d(110)≤3.30A.
SPINEL, a_0=8.05A.
SPINEL, a_0=8.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-190-5

B-1900 1100°C 1.00hr CYCLES 200.00hr TEST 2.306mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.24
15.00	-0.76
30.00	-1.06
45.00	-1.07
60.00	-1.14
75.00	-1.15
90.00	-1.20
100.00	-1.15
115.00	-1.15
130.00	-1.21
145.00	-1.17
160.00	-1.19
175.00	-1.20
190.00	-1.24
200.00	-1.20

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-190-5

B-1900 1100°C 1.00hr CYCLES 200.00hr TEST 2.306mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE), d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

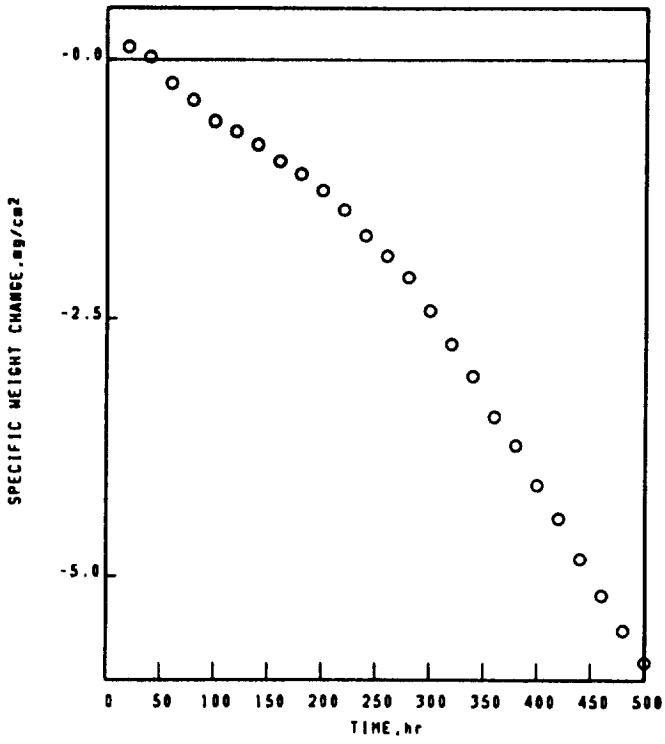
SPALL
200 hr
COLLECTED SPALL
Al_2O_3
TRI(RUTILE), d(110)≤3.30A.
Cr_2O_3

UNKNOWN LINES, d VALUES
1.38A.

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-231-S

B-1900 1100°C 20.00hr CYCLES 500.00hr TEST 2.331mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
20.00	0.12
40.00	0.02
60.00	-0.22
80.00	-0.39
100.00	-0.58
120.00	-0.68
140.00	-0.81
160.00	-0.97
180.00	-1.09
200.00	-1.26
220.00	-1.44
240.00	-1.69
260.00	-1.89
280.00	-2.18
300.00	-2.42
320.00	-2.75
340.00	-3.06
360.00	-3.44
380.00	-3.72
400.00	-4.10
420.00	-4.42
440.00	-4.82
460.00	-5.18
480.00	-5.52
500.00	-5.83

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-231-S

B-1900 1100°C 20.00hr CYCLES 500.00hr TEST 2.331mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
500 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

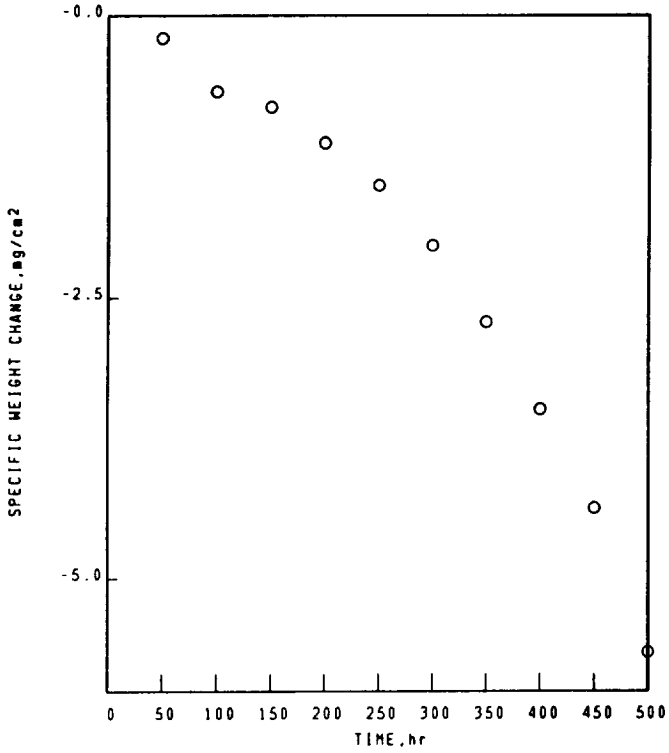
FACE CENTERED CUBIC MATRIX

SPALL
500 hr
COLLECTED SPALL
Al_2O_3
SPINEL, a_0=8.10A.
NIO
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
Cr_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-238-S

B-1900 1100°C 50.00hr CYCLES 500.00hr TEST 2.325mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm^2
0.00	0.00
50.00	-0.20
100.00	-0.67
150.00	-0.81
200.00	-1.12
250.00	-1.50
300.00	-2.03
350.00	-2.72
400.00	-3.49
450.00	-4.37
500.00	-5.65

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-238-S

B-1900 1100°C 50.00hr CYCLES 500.00hr TEST 2.325mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
500 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE), d(110)≤3.30A.

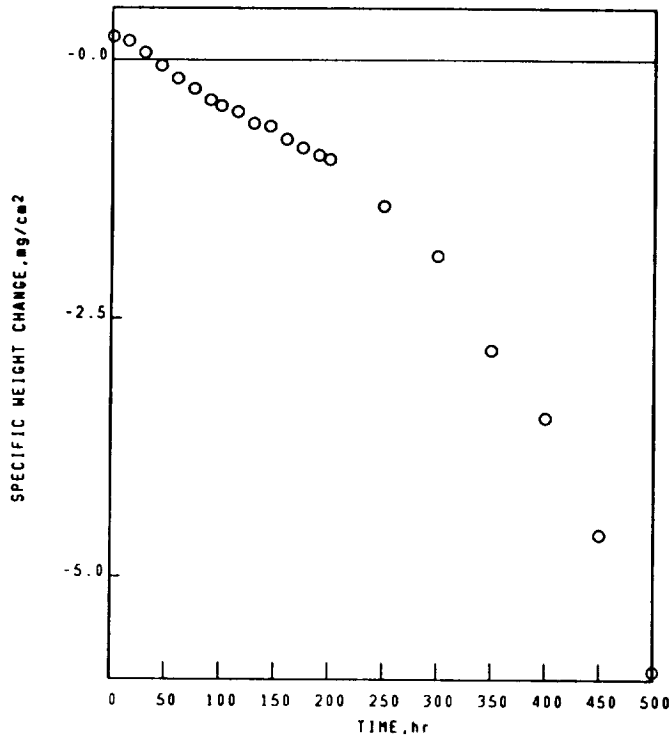
FACE CENTERED CUBIC MATRIX

SPALL
500 hr
COLLECTED SPALL
Al_2O_3
SPINEL, a_0=8.10A.
NiO
SPINEL, a_0=8.25A.
TRI(RUTILE), d(110)≤3.30A.
Cr_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-276-6

B-1900 1100°C 1.00hr CYCLES 500.00hr TEST 2.319mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.22
15.00	0.18
30.00	0.07
45.00	-0.06
60.00	-0.18
75.00	-0.28
90.00	-0.39
100.00	-0.45
115.00	-0.51
130.00	-0.62
145.00	-0.65
160.00	-0.77
175.00	-0.86
190.00	-0.93
200.00	-0.97
250.00	-1.42
300.00	-1.89
350.00	-2.81
400.00	-3.46
450.00	-4.59
500.00	-5.92

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-276-6

B-1900 1100°C 1.00hr CYCLES 500.00hr TEST 2.319mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
TRI(RUTILE), d(110)≤3.30A.
Al_2O_3

FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
TRI(RUTILE), d(110)>3.30A.
SPINEL, a_0=8.10A.

UNKNOWN LINES, d VALUES
5.06A.
2.55A.
1.89A.

500 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
NiO
TRI(RUTILE), d(110)≤3.30A.

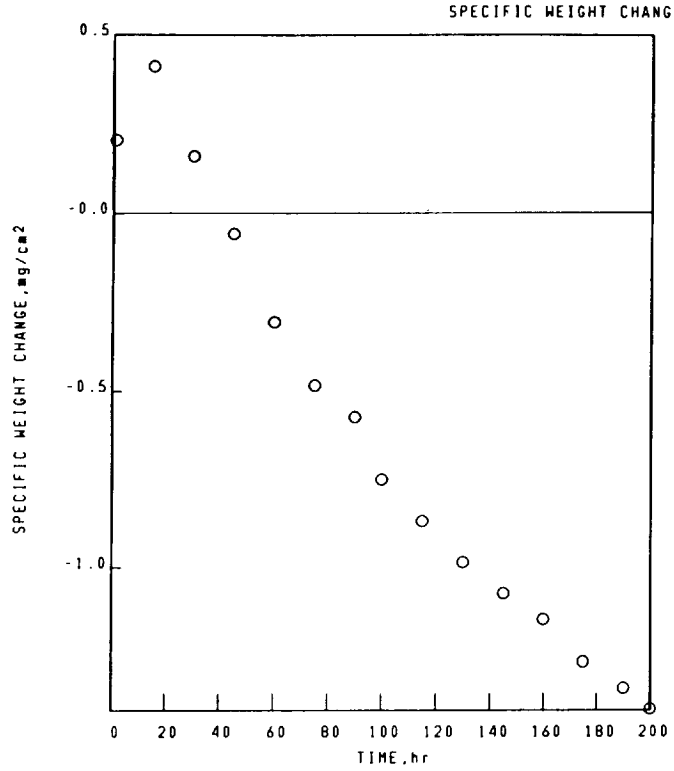
FACE CENTERED CUBIC MATRIX

500 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.05A.
Al_2O_3
TRI(RUTILE), d(110)>3.30A.
SPINEL, a_0=8.25A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-324-2

B-1900 1100°C 1.00hr CYCLES 200.00hr TEST 2.333mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm^2
0.00	0.00
1.00	0.21
15.00	0.41
30.00	0.16
45.00	-0.06
60.00	-0.31
75.00	-0.48
90.00	-0.57
100.00	-0.75
115.00	-0.87
130.00	-0.98
145.00	-1.07
160.00	-1.15
175.00	-1.26
190.00	-1.34
200.00	-1.40

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-324-2

B-1900 1100°C 1.00hr CYCLES 200.00hr TEST 2.333mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE), d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

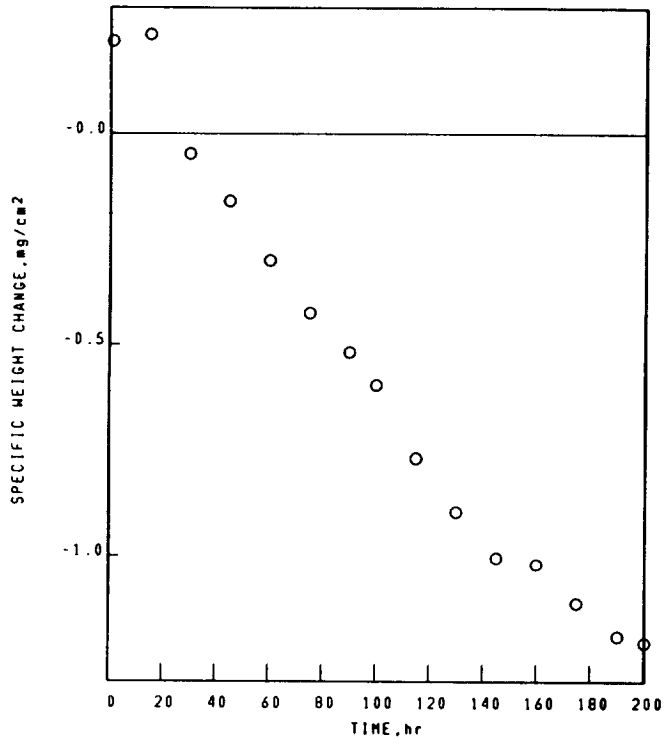
SPALL
200 hr
COLLECTED SPALL
NiO
TRI(RUTILE), d(110)≤3.30A.
SPINEL, a_0=8.25A.
SPINEL, a_0=8.10A.

UNKNOWN LINES, d VALUES
3.10A.
3.69A.
3.57A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-327-1

B-1900 1100°C 1.00hr CYCLES 200.00hr TEST 2.340mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.22
15.00	0.24
30.00	-0.05
45.00	-0.16
60.00	-0.30
75.00	-0.42
90.00	-0.52
100.00	-0.60
115.00	-0.77
130.00	-0.89
145.00	-1.00
160.00	-1.02
175.00	-1.11
190.00	-1.19
200.00	-1.21

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-327-1

B-1900 1100°C 1.00hr CYCLES 200.00hr TEST 2.340mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
Al_2O_3
SPINEL, a_0=8.05A.

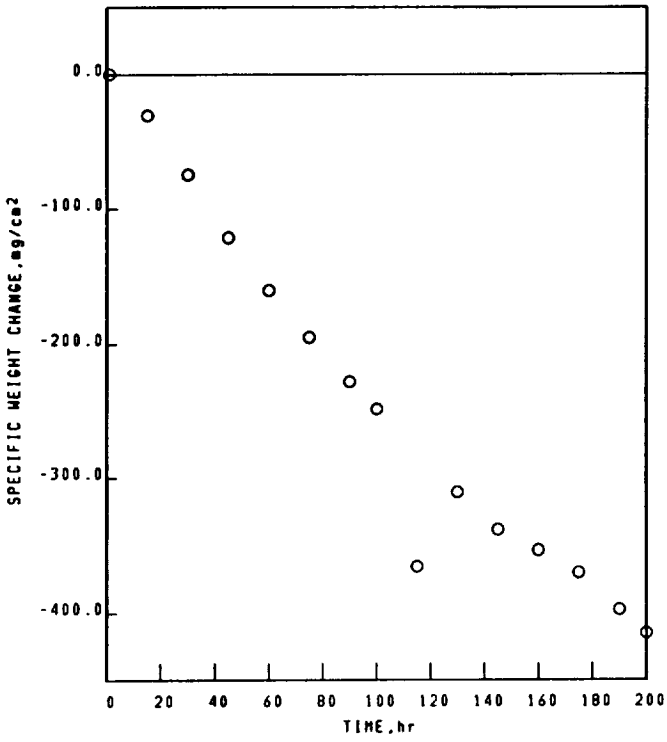
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
PROBABLE CROSS-SPALL
SPINEL, a_0=8.30A.
CoO
TRI(RUTILE), d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-336-4

B-1900 1100°C 1.00hr CYCLES 200.00hr TEST 2.317mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.17
15.00	-30.30
30.00	-74.68
45.00	-121.38
60.00	-159.93
75.00	-194.87
90.00	-228.06
100.00	-248.76
115.00	-365.43
130.00	-310.86
145.00	-338.69
160.00	-353.51
175.00	-369.90
190.00	-397.49
200.00	-414.90

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-336-4

B-1900 1100°C 1.00hr CYCLES 200.00hr TEST 2.317mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.15A.
TRI(RUTILE), d(110)≤3.30A.
$Ni(W,Mo)O_4$ TYPE 2

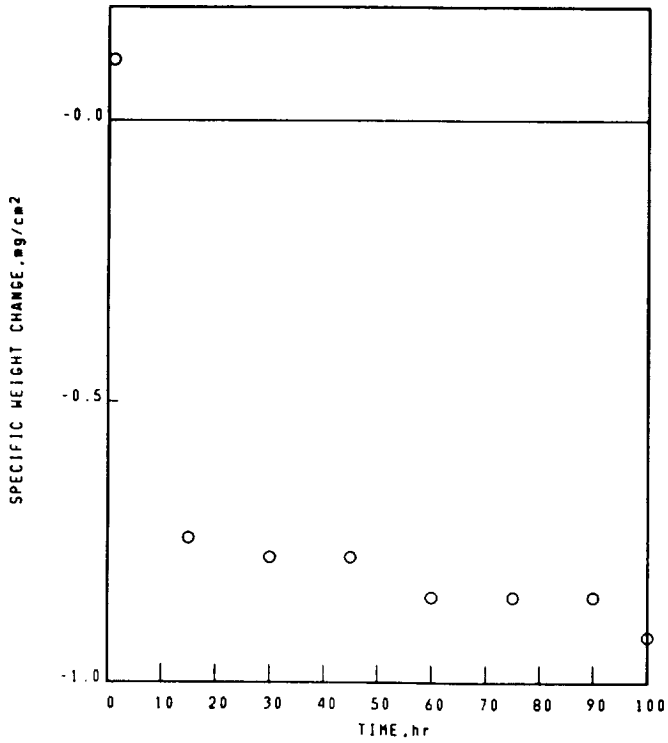
SPALL
200 hr
COLLECTED SPALL
NiO
TRI(RUTILE), d(110)>3.30A.
SPINEL, a_0=8.15A.
$Ni(W,Mo)O_4$ TYPE 2

FACE CENTERED CUBIC MATRIX

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-096-2

B-1900 1093°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.11
15.00	-0.74
30.00	-0.78
45.00	-0.78
60.00	-0.85
75.00	-0.85
90.00	-0.85
100.00	-0.92

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-096-2

B-1900 1093°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
NiO

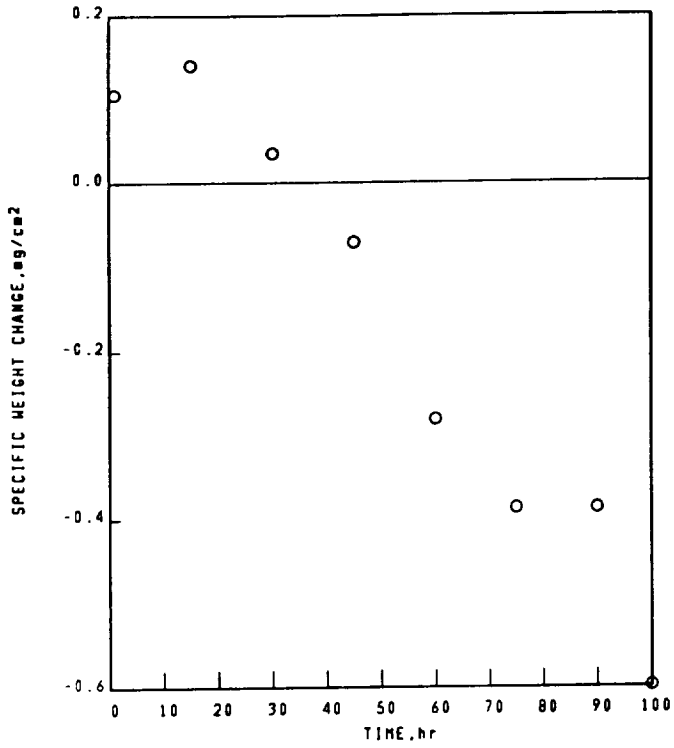
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.20A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-143-3

B-1900 1093°C 1.00hr CYCLES 100.00hr TEST 3.277mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

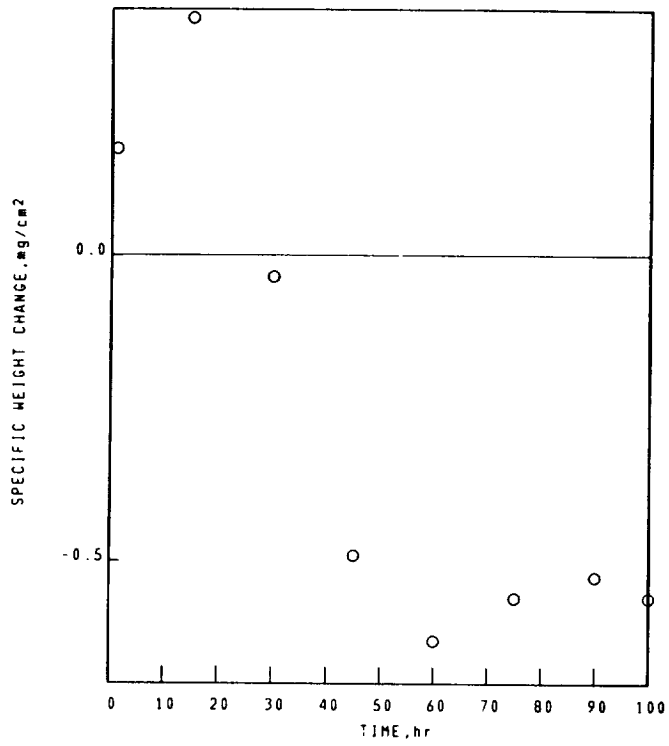


TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.11
15.00	0.14
30.00	0.04
45.00	-0.07
60.00	-0.28
75.00	-0.39
90.00	-0.39
100.00	-0.60

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-098-1

B-1900 1038°C 1.00hr CYCLES 100.00hr TEST 3.302mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.18
15.00	0.39
30.00	-0.04
45.00	-0.49
60.00	-0.63
75.00	-0.56
90.00	-0.53
100.00	-0.56

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-098-1

B-1900 1038°C 1.00hr CYCLES 100.00hr TEST 3.302mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.05A.
TRI(RUTILE), d(110)≤3.30A.

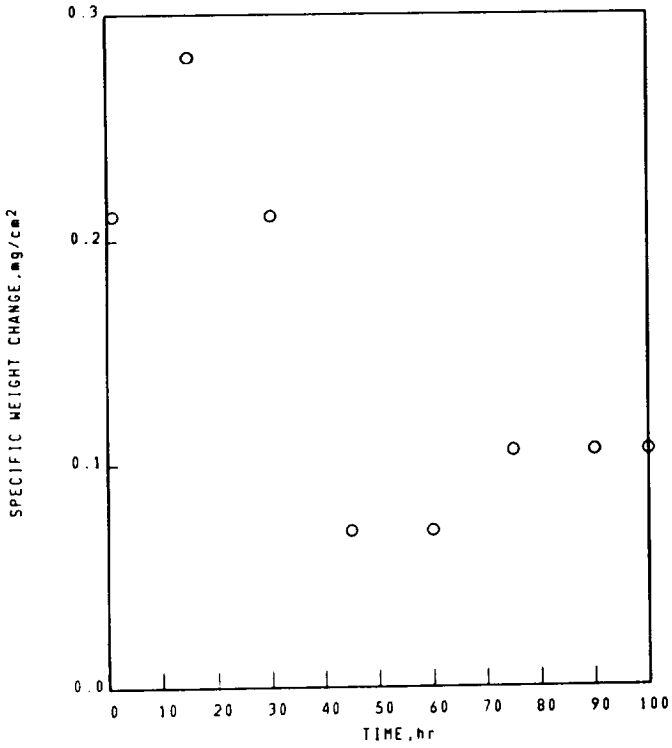
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.20A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-098-2

B-1900 1038°C 1.00hr CYCLES 100.00hr TEST 3.302mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

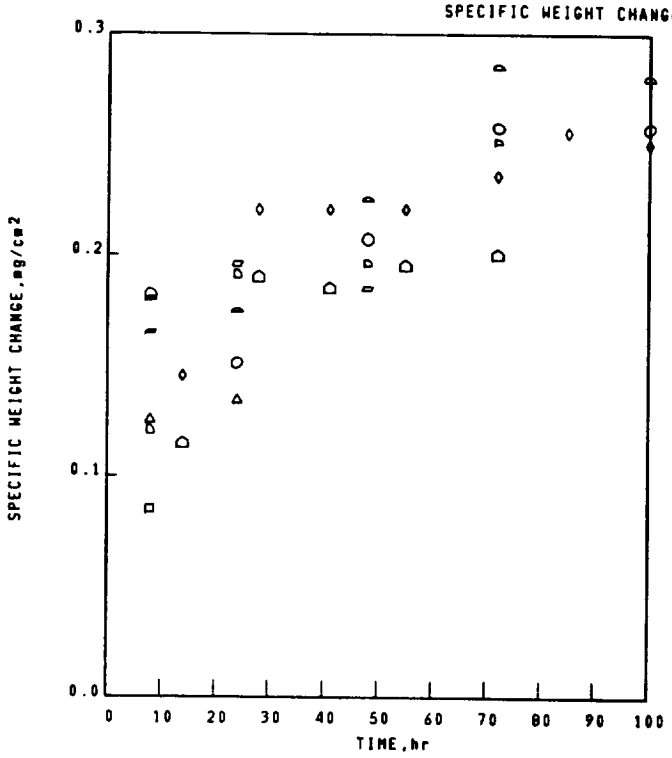


TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.21
15.00	0.28
30.00	0.21
45.00	0.07
60.00	0.07
75.00	0.11
90.00	0.11
100.00	0.11

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-001-006-6

B-1900 1000°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR(TM D-7484)

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
8.00	0.18
24.00	0.15
48.00	0.21
72.00	0.26
100.00	0.26

TIME,hr	ΔW/A,mg/cm² 006-1
0.00	0.00
8.00	0.08

TIME,hr	ΔW/A,mg/cm² 006-2
0.00	0.00
8.00	0.13
24.00	0.14

TIME,hr	ΔW/A,mg/cm² 006-3
0.00	0.00
8.00	0.17
24.00	0.20
48.00	0.19

TIME,hr	ΔW/A,mg/cm² 006-4
0.00	0.00
8.00	0.12
24.00	0.19
48.00	0.20
72.00	0.25

TIME,hr	ΔW/A,mg/cm² 006-5
0.00	0.00
8.00	0.10
24.00	0.18
48.00	0.23
72.00	0.29
100.00	0.28

TIME,hr	ΔW/A,mg/cm² 009-1
0.00	0.00
14.00	0.15
28.00	0.22
41.00	0.22
72.00	0.24
100.00	0.25
55.00	0.22
85.00	0.26

TIME,hr	ΔW/A,mg/cm² 009-6
0.00	0.00
14.00	0.12
28.00	0.19
41.00	0.19
72.00	0.20
55.00	0.20

X-RAY DIFFRACTION DATA

006-1

SURFACE
8 hr
STANDARD SURFACE
Al_2O_3
Cr_2O_3

FACE CENTERED CUBIC MATRIX

SPALL
8 hr
NO SIGNIFICANT SPALL OBSERVED

X-RAY DIFFRACTION DATA

006-5

SURFACE
100 hr
STANDARD SURFACE
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

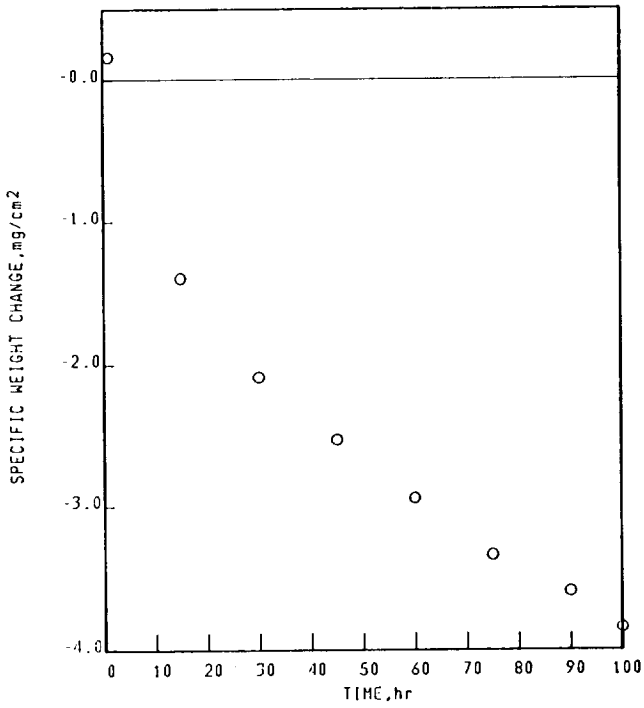
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
NO SIGNIFICANT SPALL OBSERVED

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-002-323-3

B-1900+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.16
15.00	-1.39
30.00	-2.09
45.00	-2.53
60.00	-2.94
75.00	-3.34
90.00	-3.59
100.00	-3.85

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-002-323-3

B-1900+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
HfO_2
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

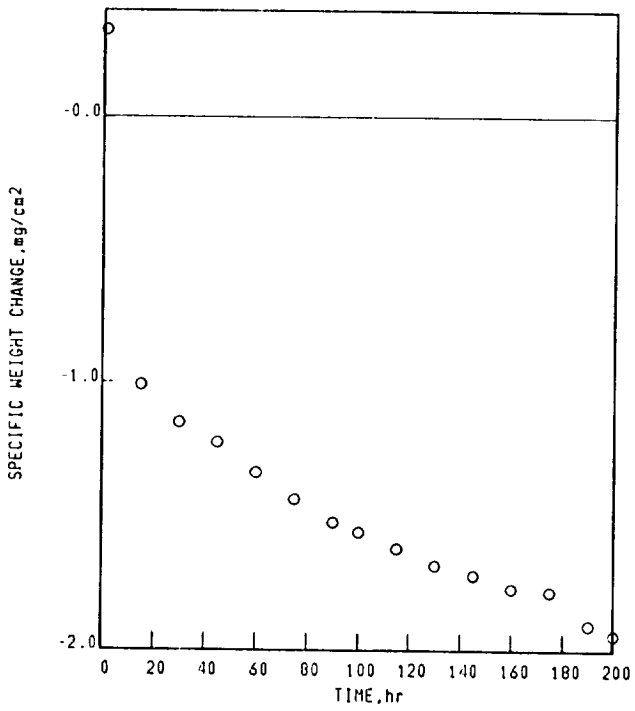
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
PROBABLE CROSS-SPALL
NiO
SPINEL, a_0=8.30A.
TRI(RUTILE),d(110)≤3.30A.
$Ni(W,Mo)O_4$ TYPE 1
CoO

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-002-190-4

B-1900+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.342mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.32
15.00	-1.01
30.00	-1.15
45.00	-1.22
60.00	-1.33
75.00	-1.43
90.00	-1.52
100.00	-1.56
115.00	-1.62
130.00	-1.68
145.00	-1.72
160.00	-1.77
175.00	-1.78
190.00	-1.91
200.00	-1.94

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-002-190-4

B-1900+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.342mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

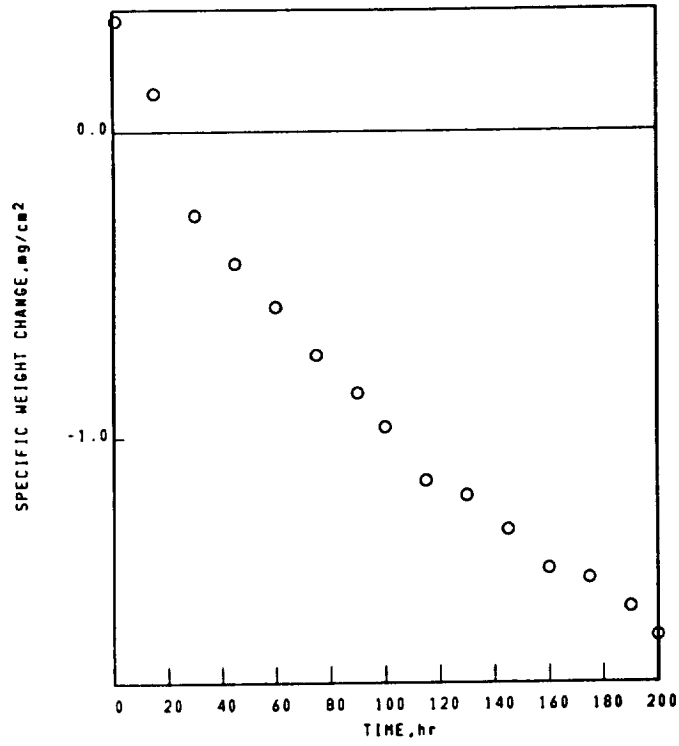
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.20A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-002-326-3

B-1900+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.330mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.36
15.00	0.13
30.00	-0.27
45.00	-0.43
60.00	-0.57
75.00	-0.73
90.00	-0.85
100.00	-0.97
115.00	-1.14
130.00	-1.19
145.00	-1.30
160.00	-1.42
175.00	-1.46
190.00	-1.55
200.00	-1.65

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-002-326-3

B-1900+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.330mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.05A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.
HfO_2

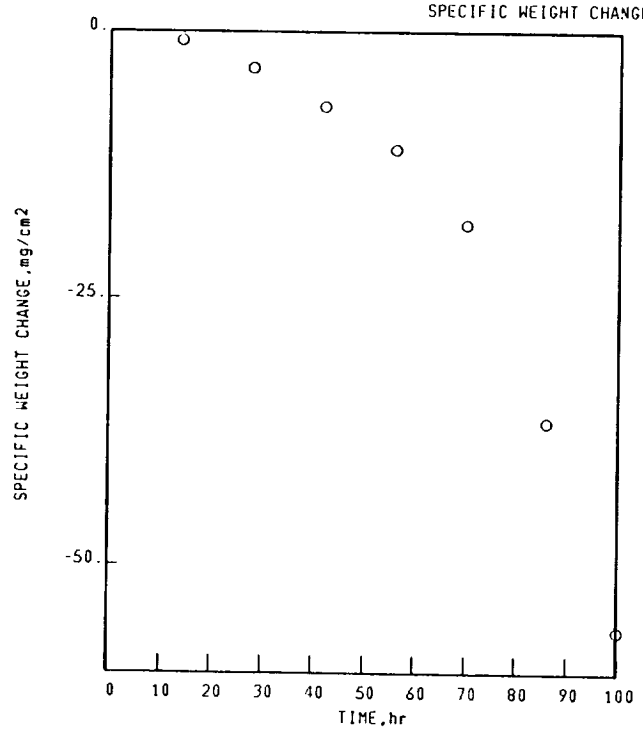
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
PROBABLE CROSS-SPALL
SPINEL, a_0=8.35A.
CoO
Al_2TiO_5
TRI(RUTILE),d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-041-6

IN-100 1150°C 1.00hr CYCLES 100.00hr TEST 2.408mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
14.00	-0.90
28.00	-3.43
42.00	-6.98
56.00	-10.98
70.00	-18.04
86.00	-36.52
100.00	-56.20

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-041-6

IN-100 1150°C 1.00hr CYCLES 100.00hr TEST 2.408mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.

UNKNOWN LINES, d VALUES
2.57A.
3.29A.
3.52A.

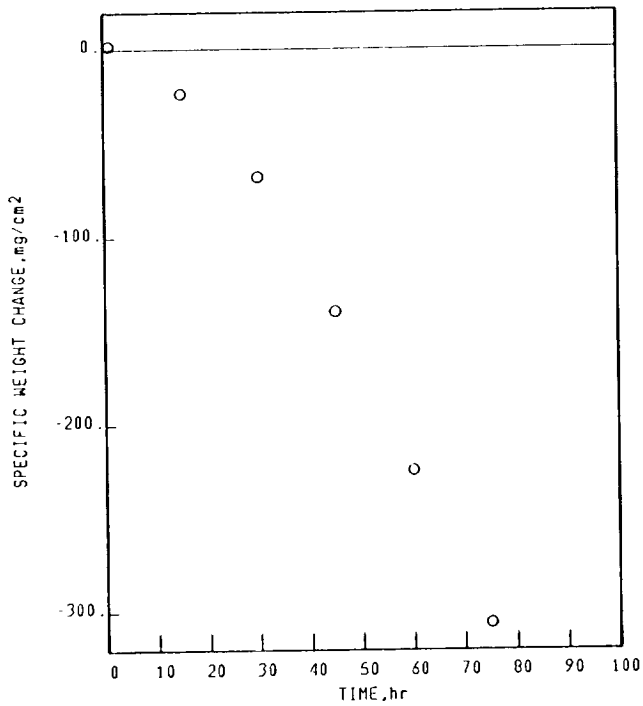
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-095-3

IN-100 1150°C 1.00hr CYCLES 75.00hr TEST 3.230mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	1.77
15.00	-23.70
30.00	-67.54
45.00	-139.84
60.00	-224.20
75.00	-306.01

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-095-3

IN-100 1150°C 1.00hr CYCLES 75.00hr TEST 3.230mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
75 hr
STANDARD SURFACE
SPINEL, a_0=8.30A.

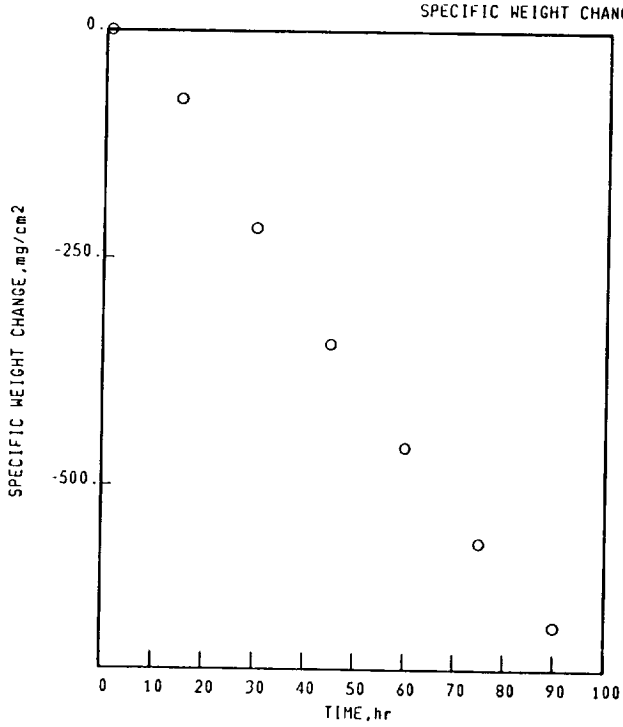
FACE CENTERED CUBIC MATRIX

SPALL
75 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-105-1

IN-100 1150°C 1.00hr CYCLES 90.00hr TEST 2.620mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

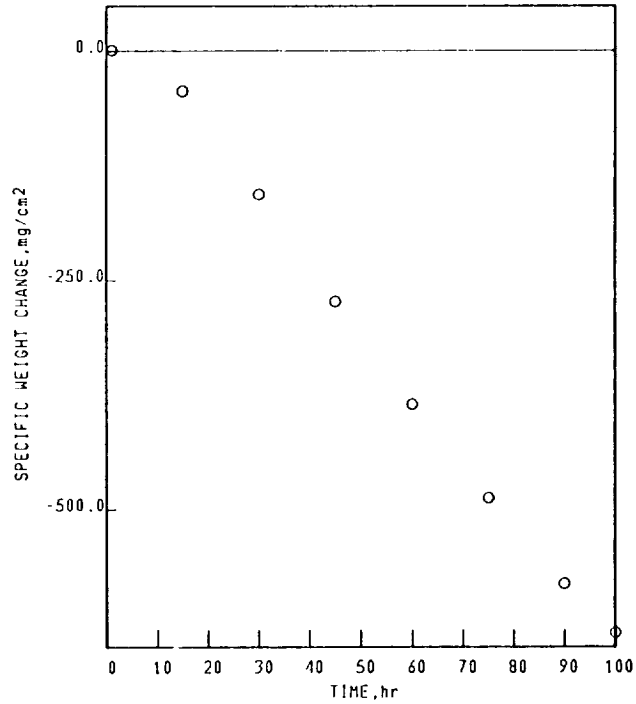


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	-0.01
15.00	-75.43
30.00	-217.51
45.00	-343.81
60.00	-457.74
75.00	-561.97
90.00	-652.69

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-105-2

IN-100 1150°C 1.00hr CYCLES 100.00hr TEST 2.625mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.69
15.00	-42.66
30.00	-155.34
45.00	-273.51
60.00	-384.80
75.00	-487.43
90.00	-581.66
100.00	-635.19

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-105-2

IN-100 1150°C 1.00hr CYCLES 100.00hr TEST 2.625mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.25A.
Cr_2O_3

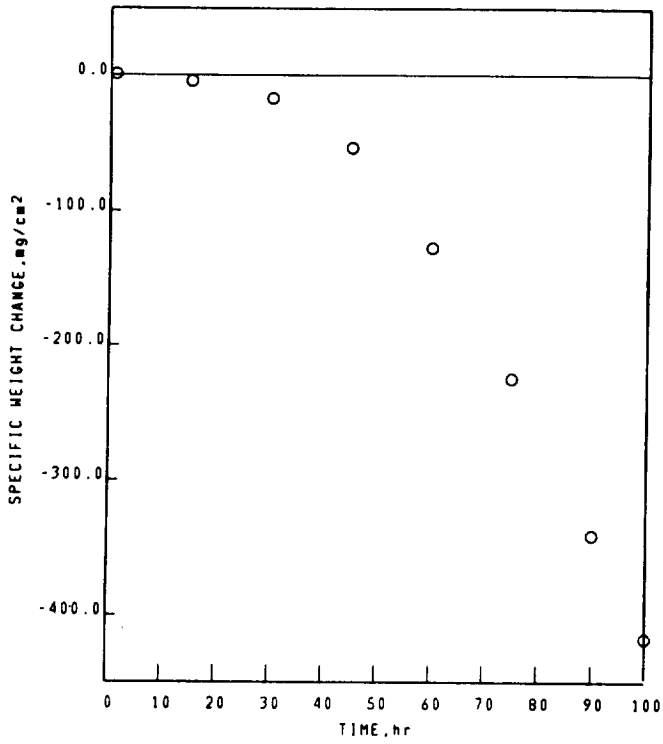
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.20A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-127-1

IN-100 1150°C 1.00hr CYCLES 100.00hr TEST 12.700mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

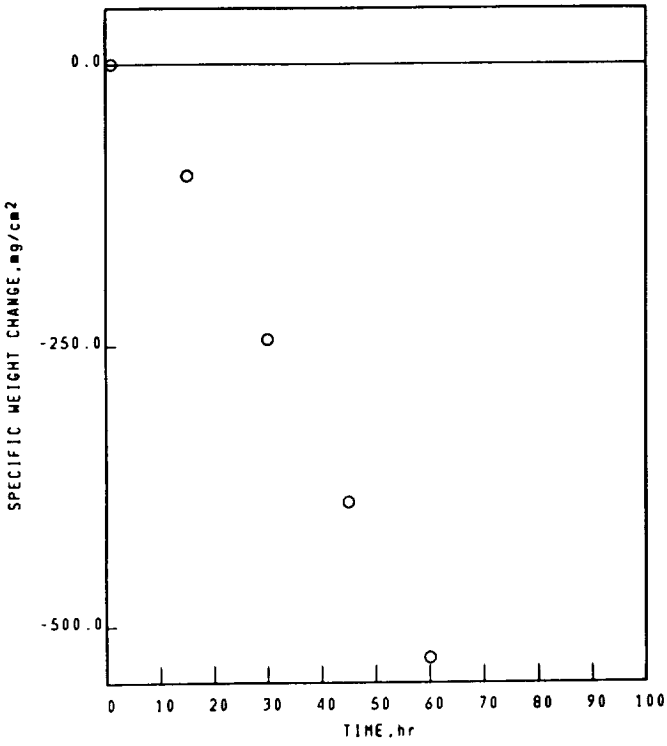


TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.63
15.00	-4.39
30.00	-17.33
45.00	-54.04
60.00	-127.53
75.00	-225.13
90.00	-340.24
100.00	-417.57

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-127-2

IN-100 1150°C 1.00hr CYCLES 60.00hr TEST 12.700mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

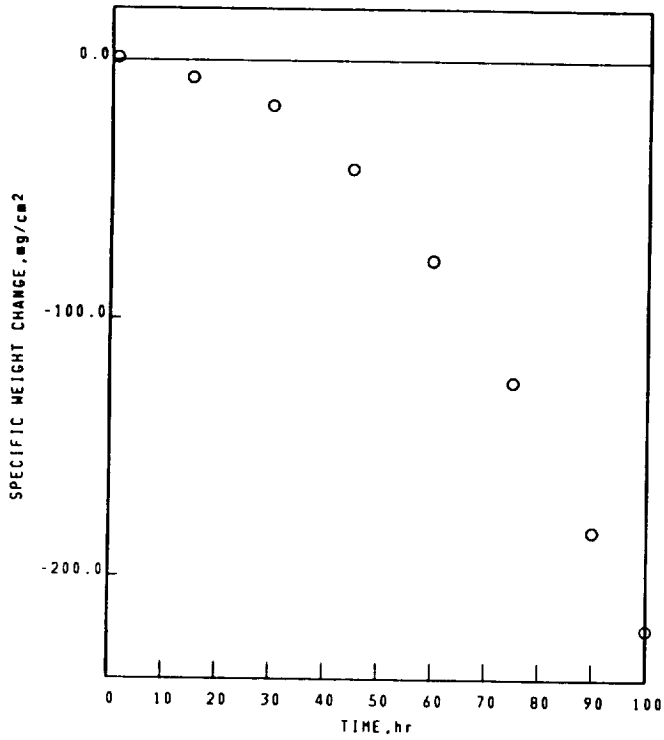


TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.21
15.00	-97.62
30.00	-244.31
45.00	-388.61
60.00	-527.85

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-127-3

IN-100 1150°C 1.00hr CYCLES 100.00hr TEST 2.630mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

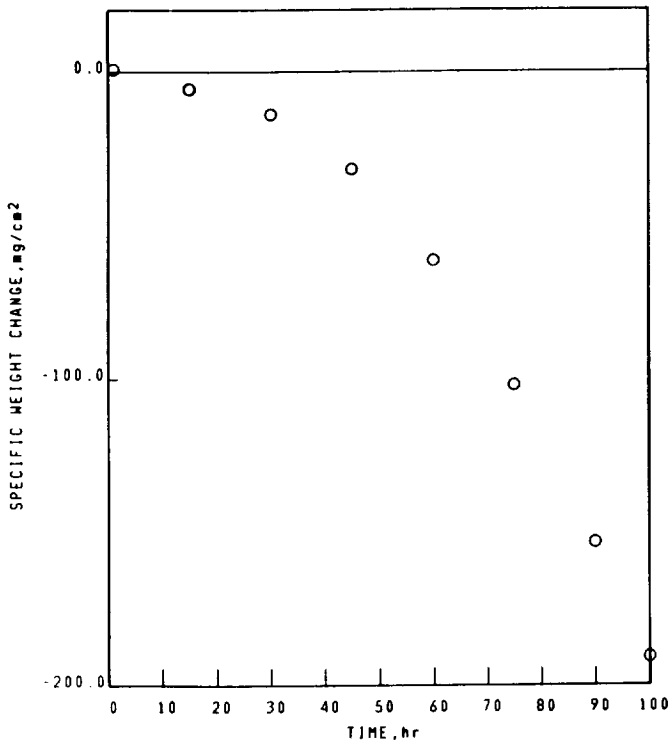


TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.95
15.00	-6.73
30.00	-17.49
45.00	-42.23
60.00	-77.46
75.00	-124.49
90.00	-182.49
100.00	-220.17

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-127-4

IN-100 1150°C 1.00hr CYCLES 100.00hr TEST 2.637mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.74
15.00	-5.33
30.00	-13.61
45.00	-31.39
60.00	-61.49
75.00	-102.03
90.00	-153.57
100.00	-190.98

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-127-4

IN-100 1150°C 1.00hr CYCLES 100.00hr TEST 2.637mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
SPINEL, a_0=8.25A.
NiO
TRI(RUTILE), d(110)≤3.30A.

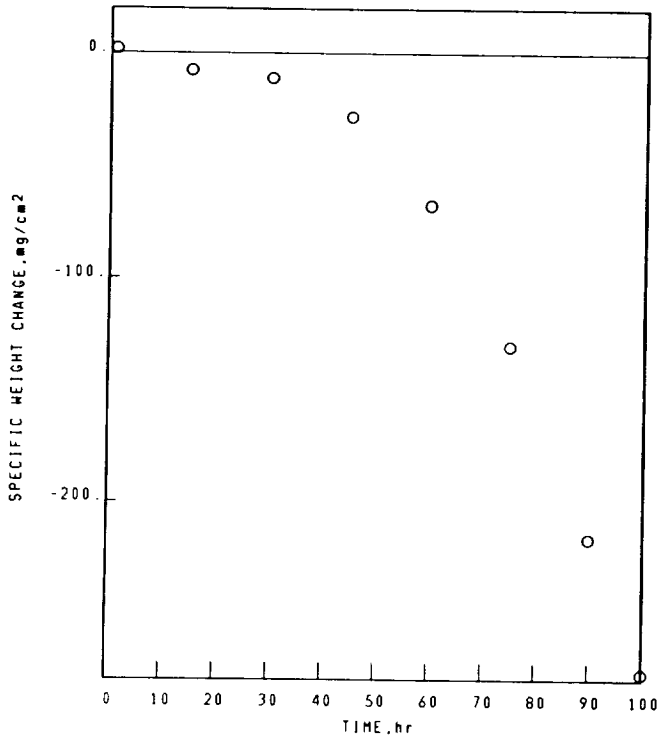
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
$Ni(W,Mo)O_4$ TYPE 2

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-127-5

IN-100 1150°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

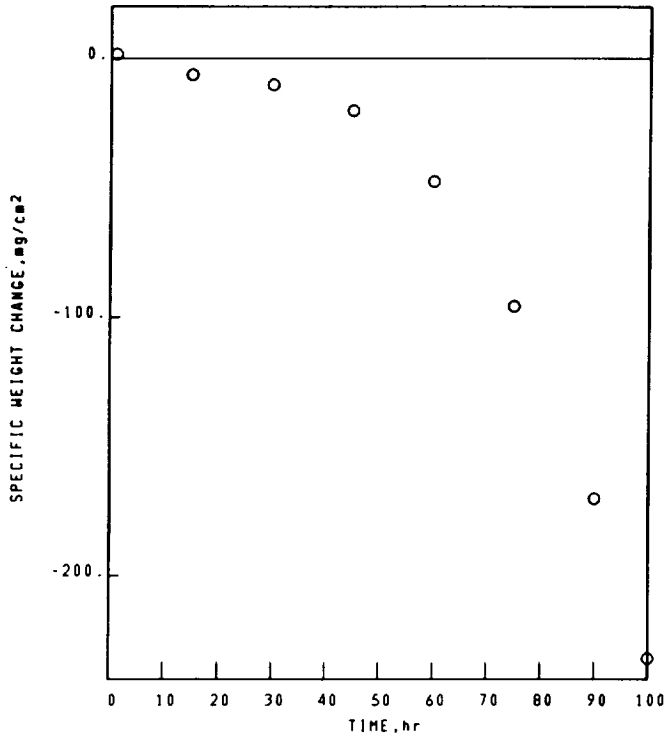


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	1.84
15.00	-7.67
30.00	-11.34
45.00	-28.51
60.00	-67.52
75.00	-130.70
90.00	-216.31
100.00	-277.22

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-127-6

IN-100 1150°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

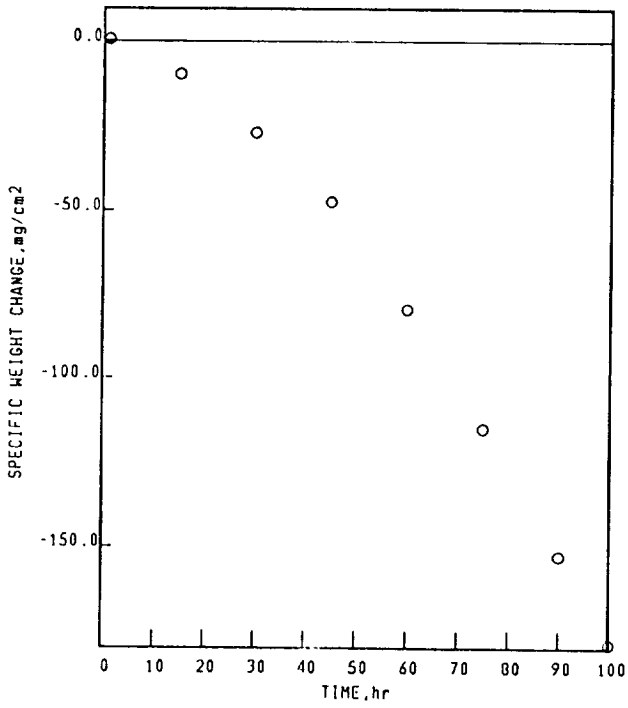


TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	1.63
15.00	-6.32
30.00	-10.14
45.00	-20.18
60.00	-47.95
75.00	-95.89
90.00	-170.45
100.00	-231.93

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-096-3

IN-100 1093°C 1.00hr CYCLES 100.00hr TEST 3.226mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

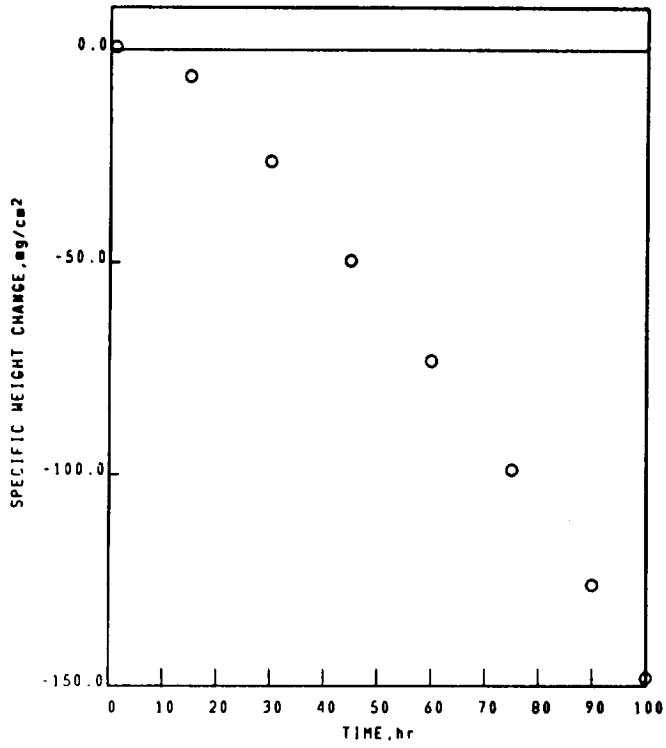


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.57
15.00	-9.82
30.00	-26.92
45.00	-47.40
60.00	-79.62
75.00	-114.69
90.00	-152.60
100.00	-178.98

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-096-6

IN-100 1093°C 1.00hr CYCLES 100.00hr TEST 3.277mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.60
15.00	-6.14
30.00	-26.03
45.00	-49.60
60.00	-73.34
75.00	-98.88
90.00	-126.26
100.00	-140.13

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-096-6

IN-100 1093°C 1.00hr CYCLES 100.00hr TEST 3.277mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

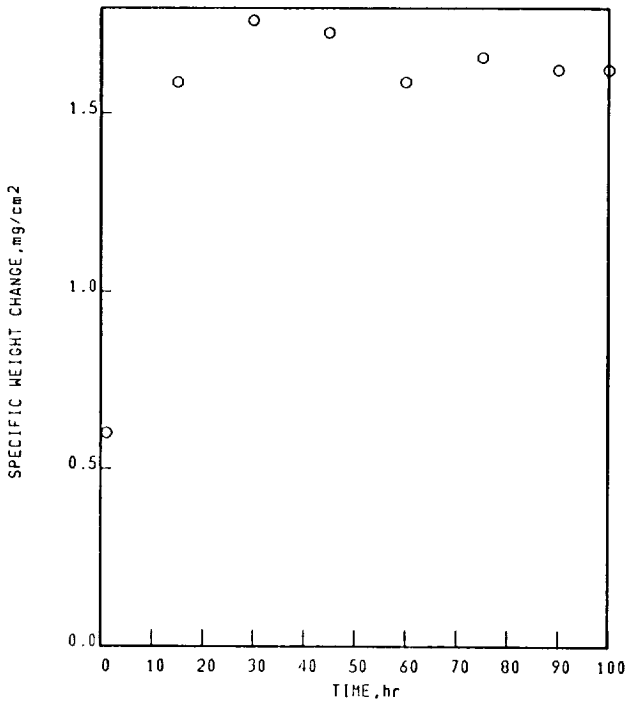
SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL, a_0=8.10A.	NiO
Cr_2O_3	SPINEL, a_0=8.30A.
NiO	Al_2O_3

FACE CENTERED CUBIC MATRIX

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-098-3

IN-100 1038°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

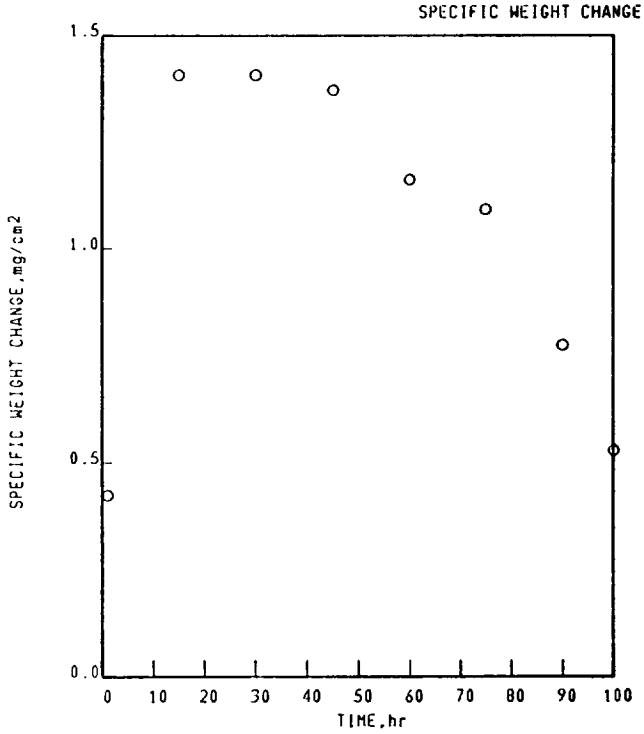


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.60
15.00	1.59
30.00	1.76
45.00	1.73
60.00	1.59
75.00	1.66
90.00	1.62
100.00	1.62

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-098-6

IN-100 1038°C 1.00hr CYCLES 100.00hr TEST 3.277mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.42
15.00	1.41
30.00	1.41
45.00	1.37
60.00	1.16
75.00	1.09
90.00	0.77
100.00	0.53

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-003-098-6

IN-100 1038°C 1.00hr CYCLES 100.00hr TEST 3.277mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
Cr_2O_3

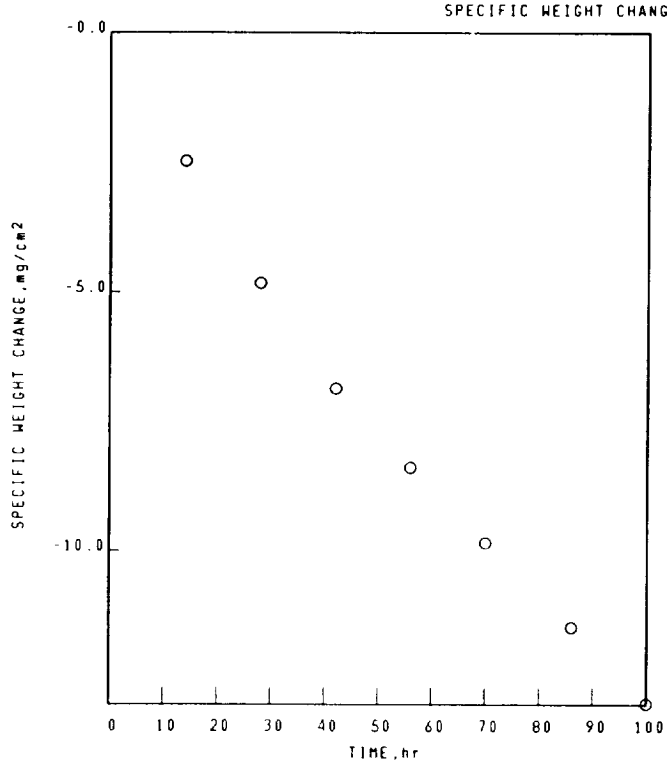
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-004-041-4

IN-713C 1150°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
14.00	-2.46
28.00	-4.83
42.00	-6.88
56.00	-8.39
70.00	-9.85
86.00	-11.50
100.00	-12.98

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-004-041-4

IN-713C 1150°C 1.00hr CYCLES 100.00hr TEST 6.509mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.15A.
TRI(RUTILE),d(110)≤3.30A.

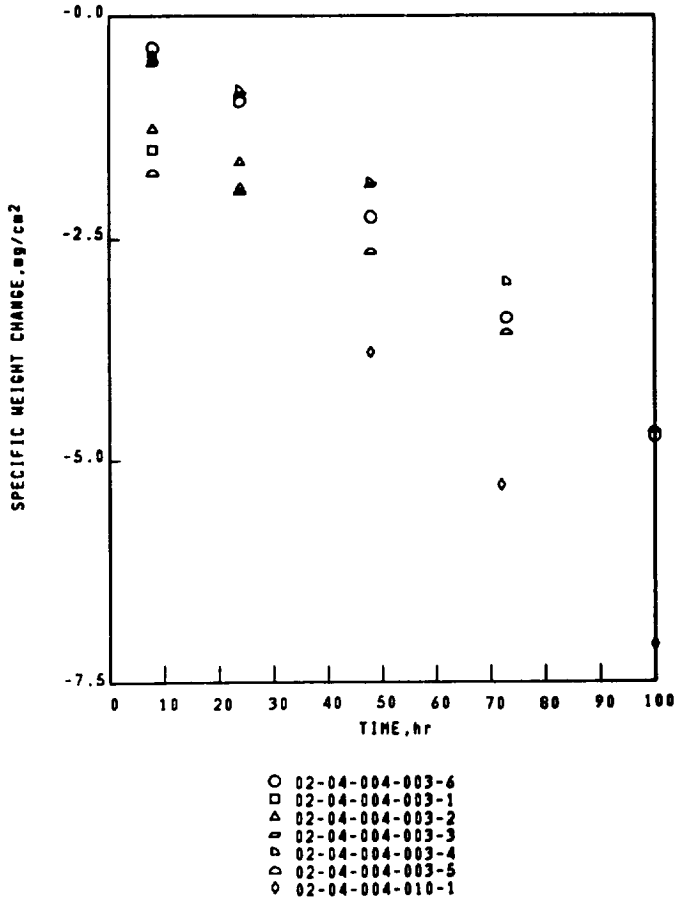
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.20A.
Cr_2O_3
Al_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-004-003-6

IN-713C 1100°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR(TM D-7484)

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
8.00	-0.36
24.00	-0.97
48.00	-2.27
73.00	-3.40
100.00	-4.74

TIME,hr	ΔW/A,mg/cm² 003-1
0.00	0.00
8.00	-1.51

TIME,hr	ΔW/A,mg/cm² 003-2
0.00	0.00
8.00	-1.27
24.00	-1.65

TIME,hr	ΔW/A,mg/cm² 003-3
0.00	0.00
8.00	-0.54
24.00	-0.88
48.00	-1.91

TIME,hr	ΔW/A,mg/cm² 003-4
0.00	0.00
8.00	-0.49
24.00	-0.85
48.00	-1.89
73.00	-3.00

TIME,hr	ΔW/A,mg/cm² 003-5
0.00	0.00
8.00	-1.77
24.00	-1.98
48.00	-2.64
73.00	-3.56
100.00	-4.67

TIME,hr	ΔW/A,mg/cm² 010-1
0.00	0.00
8.00	-0.46
24.00	-1.94
48.00	-3.78
72.00	-5.29
100.00	-7.07

X-RAY DIFFRACTION DATA

SURFACE
8 hr
STANDARD SURFACE
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3
Cr_2O_3

FACE CENTERED CUBIC MATRIX

SPALL
8 hr
NO SIGNIFICANT SPALL OBSERVED

003-1

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

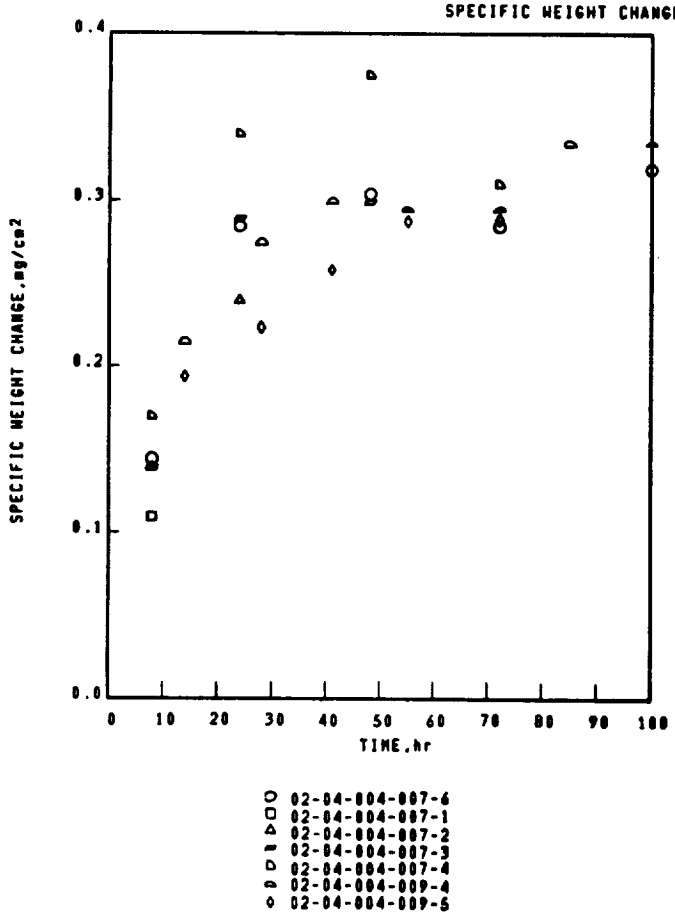
SPALL
100 hr
COLLECTED SPALL
SPINEL, a_0=8.25A.
NiO
Al_2O_3

003-5

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 82-04-004-007-6

IN-713C 1000°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR(TM D-7484)

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
8.00	0.14
24.00	0.28
48.00	0.30
72.00	0.28
100.00	0.32

TIME,hr	ΔW/A,mg/cm² 007-1
0.00	0.00
8.00	0.11

TIME,hr	ΔW/A,mg/cm² 007-2
0.00	0.00
8.00	0.14
24.00	0.24

TIME,hr	ΔW/A,mg/cm² 007-3
0.00	0.00
8.00	0.14
24.00	0.29
48.00	0.30

TIME,hr	ΔW/A,mg/cm² 007-4
0.00	0.00
8.00	0.17
24.00	0.34
48.00	0.37
72.00	0.31

TIME,hr	ΔW/A,mg/cm² 009-4
0.00	0.00
14.00	0.22
28.00	0.28
41.00	0.30
72.00	0.30
100.00	0.34
55.00	0.30
85.00	0.34

TIME,hr	ΔW/A,mg/cm² 009-5
0.00	0.00
14.00	0.19
28.00	0.22
41.00	0.26
72.00	0.29
55.00	0.29

X-RAY DIFFRACTION DATA

SURFACE
0 hr
STANDARD SURFACE
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

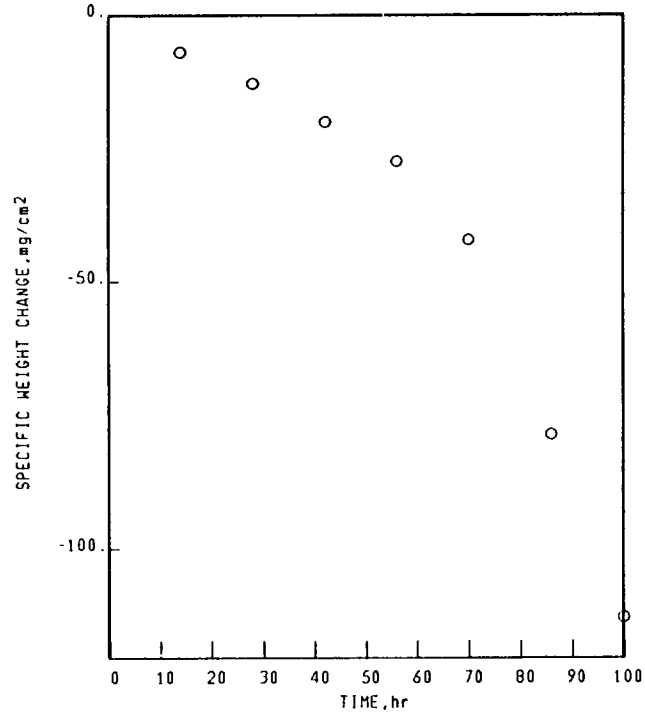
FACE CENTERED CUBIC MATRIX

SPALL
0 hr
NO SIGNIFICANT SPALL OBSERVED

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-005-041-2

IN-738 1150°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
14.00	-6.81
28.00	-12.70
42.00	-19.92
56.00	-27.31
70.00	-42.21
86.00	-78.39
100.00	-112.61

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-005-041-2

IN-738 1150°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

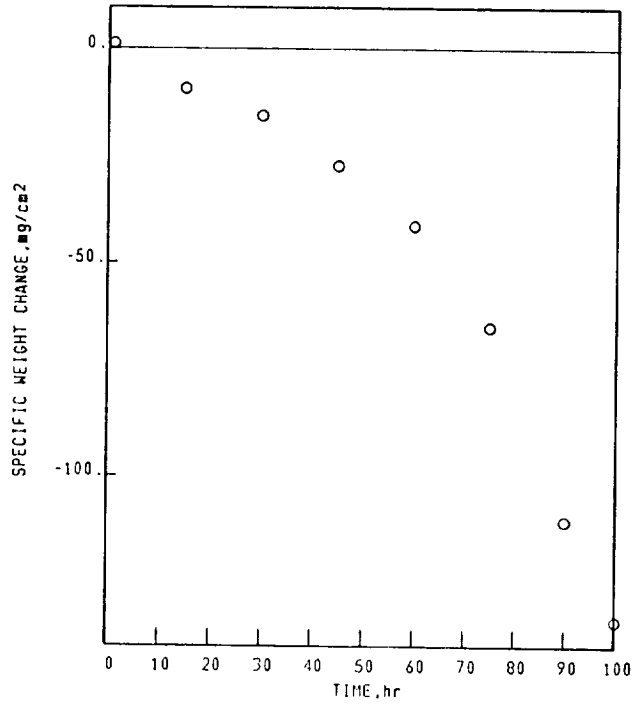
SURFACC
100 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.30A.
Cr_2O_3

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-005-321-1

IN-738 1150°C 1.00hr CYCLES 100.00hr TEST 2.321mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	1.12
15.00	-9.45
30.00	-15.73
45.00	-27.21
60.00	-41.31
75.00	-65.26
90.00	-110.41
100.00	-134.14

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-005-321-1

IN-738 1150°C 1.00hr CYCLES 100.00hr TEST 2.321mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
TRI(RUTILE),d(110)≤3.30A.
$NiTiO_3$
$Ni(W,Mo)O_4$ TYPE 2

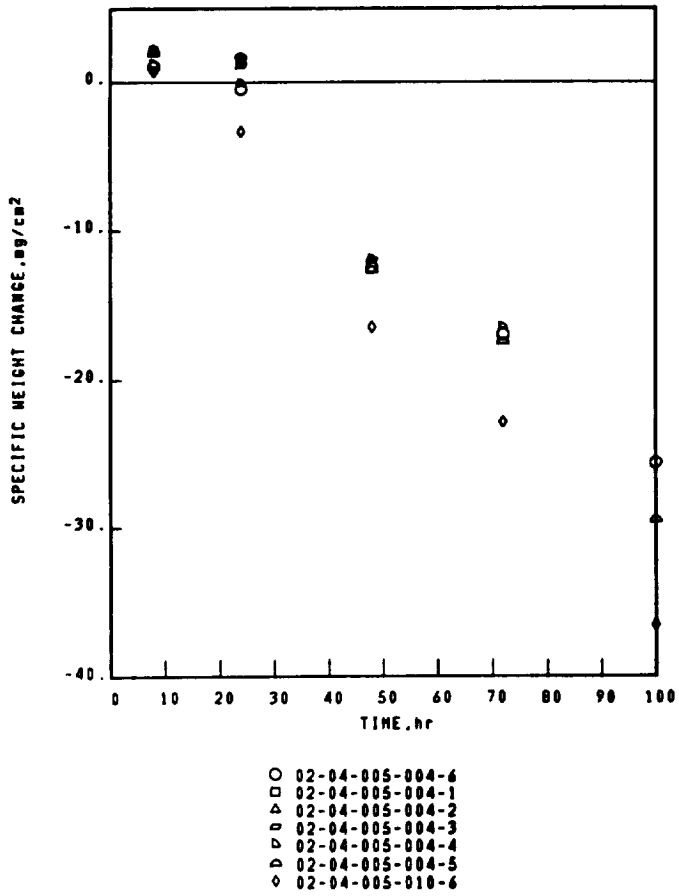
SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
TRI(RUTILE),d(110)≤3.30A.
Cr_2O_3
$NiTiO_3$

UNKNOWN LINES, d VALUES

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-005-004-6

IN-738 1100°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR(TM D-7484)

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
8.00	1.08
24.00	-0.45
48.00	-12.49
72.00	-16.94
100.00	-25.66

TIME,hr	ΔW/A,mg/cm² 004-1
0.00	0.00
8.00	2.16

TIME,hr	ΔW/A,mg/cm² 004-2
0.00	0.00
8.00	2.16
24.00	1.55

TIME,hr	ΔW/A,mg/cm² 004-3
0.00	0.00
8.00	1.97
24.00	1.09
48.00	-11.99

TIME,hr	ΔW/A,mg/cm² 004-4
0.00	0.00
8.00	1.17
24.00	-0.89
48.00	-11.95
72.00	-16.48

TIME,hr	ΔW/A,mg/cm² 004-5
0.00	0.00
8.00	1.97
24.00	1.88
48.00	-12.63
72.00	-17.39
100.00	-29.46

TIME,hr	ΔW/A,mg/cm² 010-6
0.00	0.00
8.00	0.76
24.00	-3.33
48.00	-16.41
72.00	-22.85
100.00	-36.52

X-RAY DIFFRACTION DATA

SURFACE
8 hr
STANDARD SURFACE
Cr_2O_3
TRI(RUTILE),d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

SPALL 004-1
8 hr
NO SIGNIFICANT SPALL OBSERVED

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
Cr_2O_3
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.

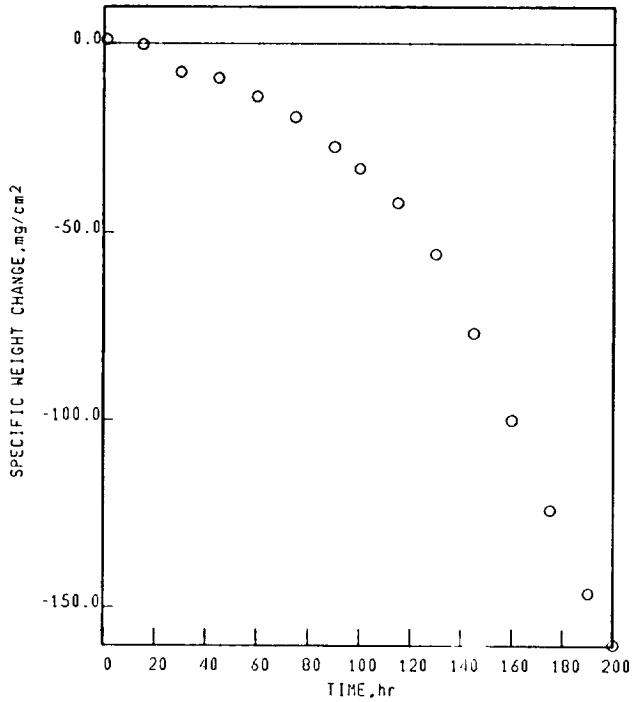
FACE CENTERED CUBIC MATRIX

SPALL 004-5
100 hr
COLLECTED SPALL
Cr_2O_3
TRI(RUTILE),d(110)≤3.30A.
NiO
SPINEL, a_0=8.25A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-005-324-1

IN-738 1100°C 1.00hr CYCLES 200.00hr TEST 2.330mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.98
15.00	-0.26
30.00	-7.66
45.00	-9.20
60.02	-14.08
75.00	-19.56
90.00	-27.20
100.00	-32.99
115.00	-42.11
130.00	-55.81
145.00	-77.00
160.00	-99.93
175.00	-123.82
190.00	-146.16
200.00	-159.84

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-005-324-1

IN-738 1100°C 1.00hr CYCLES 200.00hr TEST 2.330mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
TRI(RUTILE),d(110)≤3.30A.
$NiTiO_3$

UNKNOWN LINES, d VALUES
2.88A.

FACE CENTERED CUBIC MATRIX

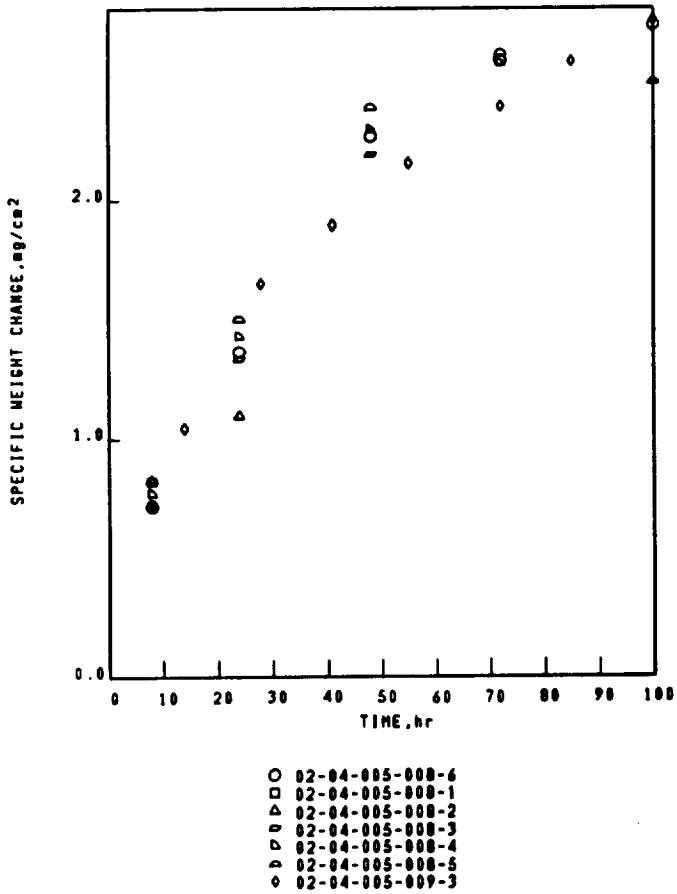
SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
TRI(RUTILE),d(110)≤3.30A.
Cr_2O_3
$NiTiO_3$
Al_2O_3

UNKNOWN LINES, d VALUES
2.90A.

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-005-000-6

IN-738 1000°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR(TN D-7484)

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
8.00	0.72
24.00	1.37
48.00	2.27
72.00	2.58
100.00	2.73

TIME,hr	ΔW/A,mg/cm² 000-1
0.00	0.00
8.00	0.02

TIME,hr	ΔW/A,mg/cm² 000-2
0.00	0.00
8.00	0.02
24.00	1.10

TIME,hr	ΔW/A,mg/cm² 000-3
0.00	0.00
8.00	0.72
24.00	1.33
48.00	2.19

TIME,hr	ΔW/A,mg/cm² 000-4
0.00	0.00
8.00	0.77
24.00	1.43
48.00	2.29
72.00	2.57

TIME,hr	ΔW/A,mg/cm² 000-5
0.00	0.00
8.00	0.02
24.00	1.50
48.00	2.39
72.00	2.62
100.00	2.49

TIME,hr	ΔW/A,mg/cm² 009-3
0.00	0.00
14.00	1.04
28.00	1.65
41.00	1.90
72.00	2.39
100.00	2.75
55.00	2.15
85.00	2.50

X-RAY DIFFRACTION DATA

SURFACE
8 hr
STANDARD SURFACE
Cr_2O_3
TRI(RUTILE),d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

SPALL 000-1
8 hr
NO SIGNIFICANT SPALL OBSERVED

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
Cr_2O_3
TRI(RUTILE),d(110)≤3.30A.

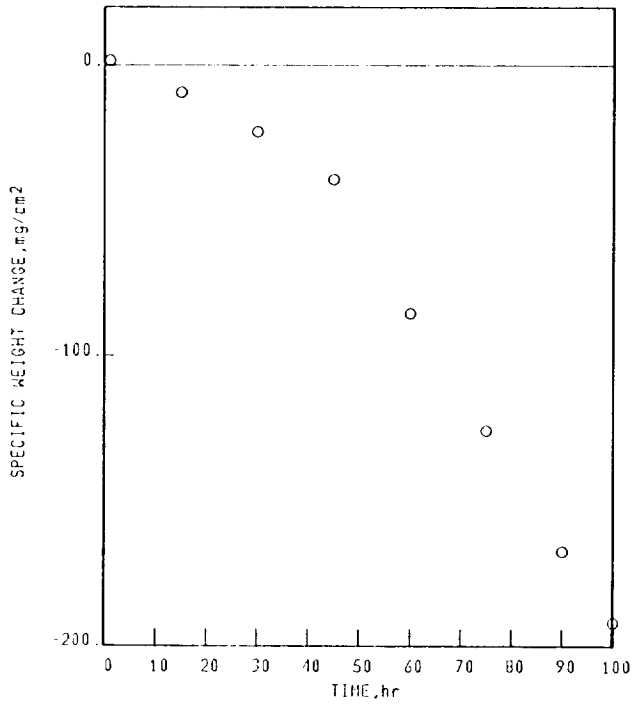
FACE CENTERED CUBIC MATRIX

SPALL 000-5
100 hr
NO SIGNIFICANT SPALL OBSERVED

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-323-2

IN-792+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.316mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	1.50
15.00	-9.27
30.00	-22.74
45.00	-39.28
60.00	-85.60
75.00	-125.66
90.00	-167.49
100.00	-192.13

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-323-2

IN-792+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.316mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
$NiTiO_3$
TRI(RUTILE),d(110)≤3.30A.
$Ni(W,Mo)O_4$ TYPE 1

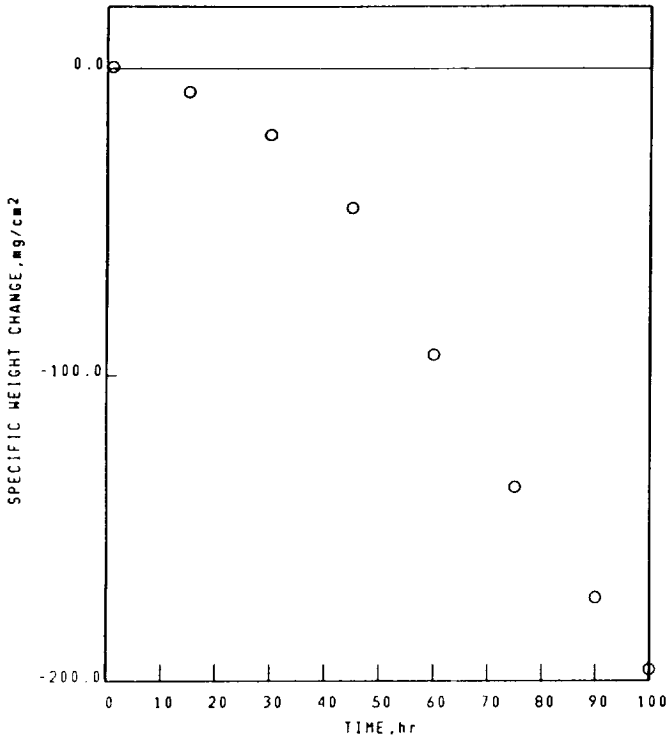
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
$Ni(W,Mo)O_4$ TYPE 1
TRI(RUTILE),d(110)≤3.30A.
Cr_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-323-S

IN-792+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.236mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.52
15.00	-7.56
30.00	-21.57
45.00	-45.61
60.00	-93.33
75.00	-136.90
90.00	-172.67
100.00	-196.23

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-323-S

IN-792+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.236mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.30A.
NiO
$Ni(W,Mo)O_4$ TYPE 1
TRI(RUTILE), d(110)≤3.30A.
Cr_2O_3

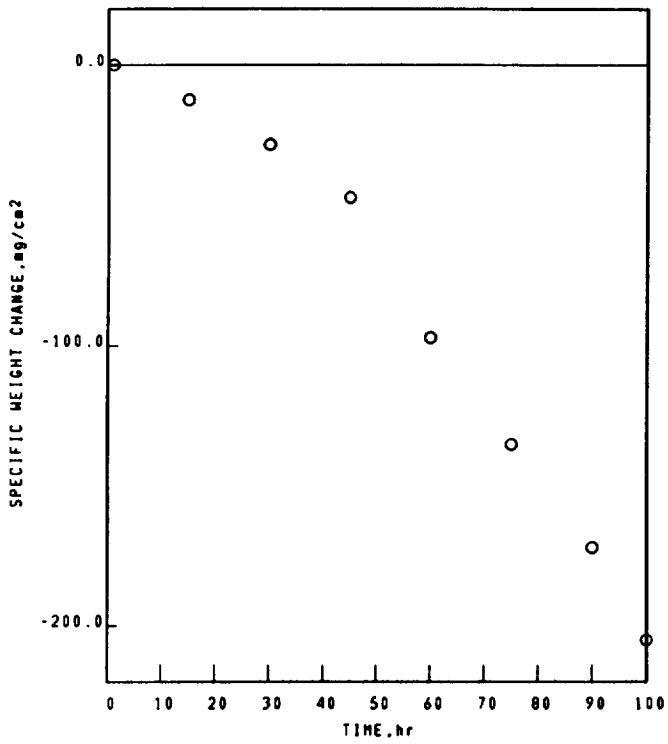
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
PROBABLE CROSS-SPALL
NiO
SPINEL, a_0=8.30A.
$Ni(W,Mo)O_4$ TYPE 1
TRI(RUTILE), d(110)≤3.30A.
CoO
$Ni(W,Mo)O_4$ TYPE 2

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-337-5

IN-792+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.322mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.08
15.00	-12.32
30.00	-27.79
45.00	-46.69
60.00	-97.05
75.00	-134.85
90.00	-171.67
100.00	-204.98

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-337-5

IN-792+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.322mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.25A.
NiO
TRI(RUTILE),d(110)≤3.30A.
Cr_2O_3
$(Ni,Co,Fe)TiO_3$
$Ni(W,Mo)O_4$ TYPE 1

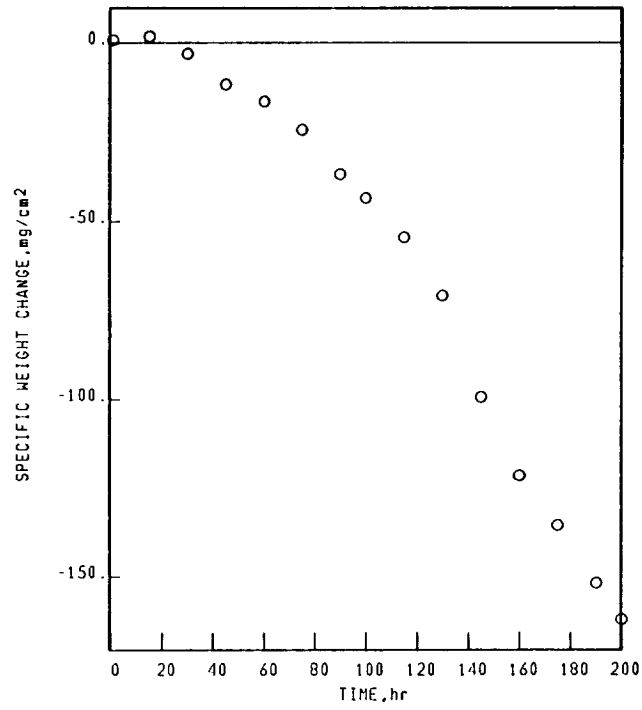
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
TRI(RUTILE),d(110)≤3.30A.
$Ni(W,Mo)O_4$ TYPE 1
$Ni(W,Mo)O_4$ TYPE 2

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-310-2

IN-792+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.302mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.77
15.00	1.78
30.00	-3.03
45.00	-11.40
60.00	-16.19
75.00	-24.17
90.00	-36.63
100.00	-43.39
115.00	-54.57
130.00	-71.02
145.00	-99.26
160.00	-121.44
175.00	-135.43
190.00	-151.70
200.00	-161.87

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-310-2

IN-792+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.302mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

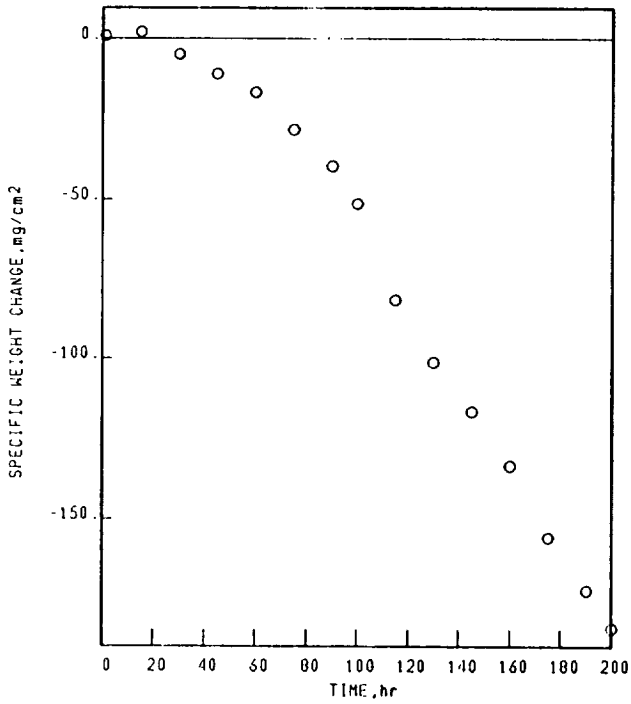
SURFACE
200 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.30A.
TRI(RUTILE),d(110)≤3.30A.
$Ni(W,Mo)O_4$ TYPE 1

SPALL
200 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-326-2

IN-792+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.315mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.86
15.00	2.13
30.00	-4.92
45.00	-11.06
60.00	-16.81
75.00	-28.50
90.00	-39.74
100.00	-51.39
115.00	-81.56
130.00	-101.25
145.00	-116.64
160.00	-133.39
175.00	-155.77
190.00	-172.59
200.00	-184.46

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-326-2

IN-792+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.315mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
$NiTiO_3$
TRI(RUTILE),d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

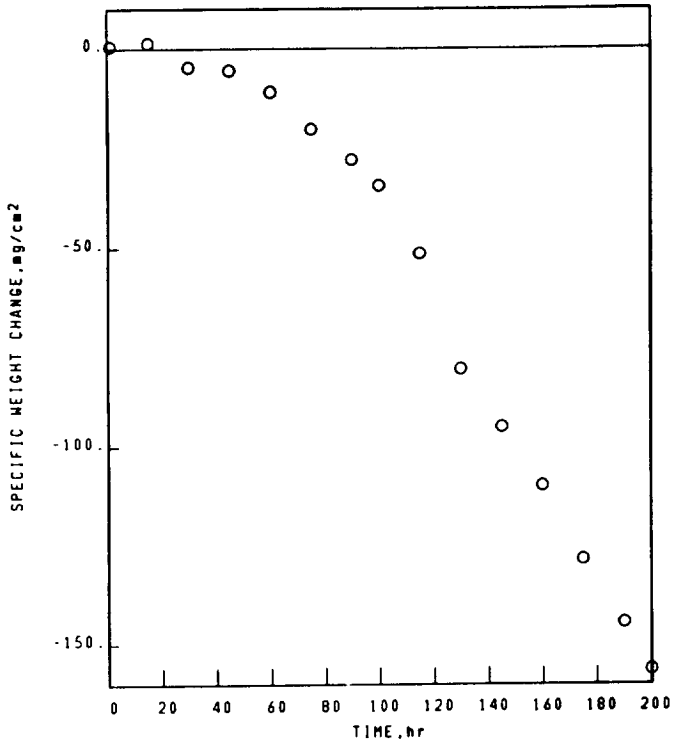
SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
TRI(RUTILE),d(110)≤3.30A.
$Ni(W,Mo)O_4$ TYPE 1
$NiTiO_3$
Cr_2O_3

UNKNOWN LINES, d VALUES
3.10A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-326-5

IN-792+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.306mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.61
15.00	1.46
30.00	-4.58
45.00	-5.35
60.00	-10.61
75.00	-19.94
90.00	-27.62
100.00	-34.19
115.00	-51.50
130.00	-80.65
145.00	-95.00
160.00	-109.95
175.00	-128.61
190.00	-144.60
200.00	-156.26

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-326-5

IN-792+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.306mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.30A.
Al_2TiO_5
SPINEL, a_0=8.10A.
Cr_2O_3
$Ni(W,Mo)O_4$ TYPE 2

FACE CENTERED CUBIC MATRIX

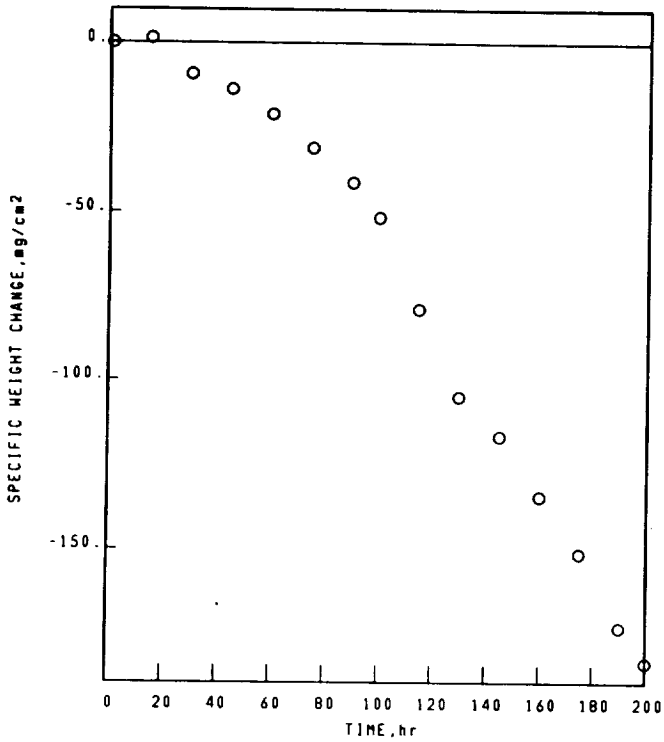
SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
$Ni(W,Mo)O_4$ TYPE 1
TRI(RUTILE), d(110)≤3.30A.
$(Ni,Co,Fe)TiO_3$
Cr_2O_3

UNKNOWN LINES, d VALUES
2.81A.
2.76A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-336-S

IN-792+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.306mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.00
15.00	1.36
30.00	-9.31
45.00	-13.80
60.00	-21.27
75.00	-31.24
90.00	-41.50
100.00	-51.69
115.00	-78.81
130.00	-105.17
145.00	-116.84
160.00	-134.69
175.00	-151.17
190.00	-173.42
200.00	-183.99

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-007-336-S

IN-792+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.306mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.30A.
TRI(RUTILE),d(110)≤3.30A.
Cr_2O_3
$(Ni,Co,Fe)TiO_3$
TRI(RUTILE),d(110)≤3.30A.
$Ni(W,Mo)O_4$ TYPE 2

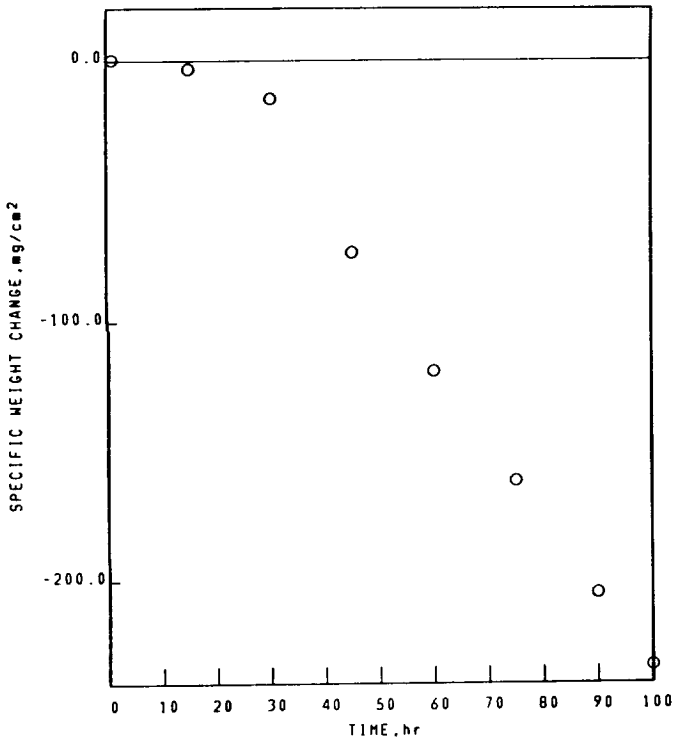
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
$Ni(W,Mo)O_4$ TYPE 1
TRI(RUTILE),d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-031-328-3

IN-939 1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.43
15.00	-3.14
30.00	-14.44
45.00	-73.87
60.00	-119.21
75.00	-161.99
90.00	-205.15
100.00	-233.19

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-031-328-3

IN-939 1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
NiO
Cr_2O_3
SPINEL, a_0=8.30A.
TRI(RUTILE), d(110)≤3.30A.

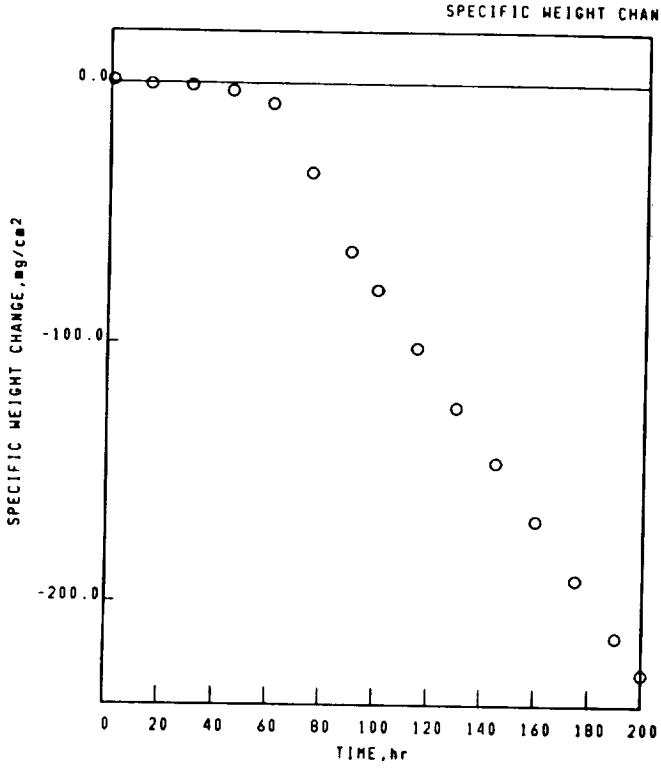
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
TRI(RUTILE), d(110)≤3.30A.
SPINEL, a_0=8.10A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-031-327-3

IN-939 1100°C 1.00hr CYCLES 200.00hr TEST 2.304mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.87
15.00	-0.59
30.00	-0.98
45.00	-2.90
60.00	-7.79
75.00	-33.99
90.00	-64.38
100.00	-79.36
115.00	-101.91
130.00	-124.90
145.00	-145.71
160.00	-168.06
175.00	-191.10
190.00	-213.46
200.00	-227.63

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-031-327-3

IN-939 1100°C 1.00hr CYCLES 200.00hr TEST 2.304mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
TRI(RUTILE), d(110)≤3.30A.

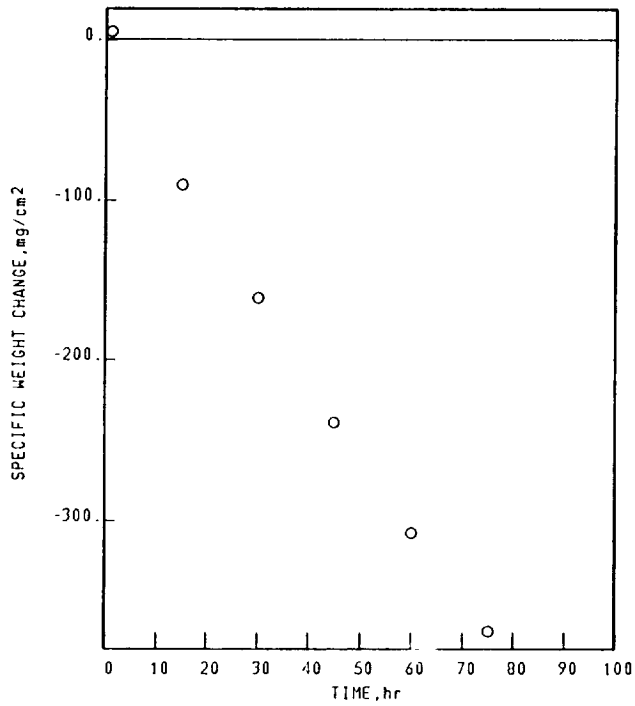
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
TRI(RUTILE), d(110)≤3.30A.
SPINEL, a_0=8.05A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-008-225-1

MAR-M-200 1150°C 1.00hr CYCLES 75.00hr TEST 2.157mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	5.12
15.00	-90.82
30.00	-161.07
45.00	-239.26
60.00	-307.63
75.00	-369.16

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-008-225-1

MAR-M-200 1150°C 1.00hr CYCLES 75.00hr TEST 2.157mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
75 hr
STANDARD SURFACE
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.10A.
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.

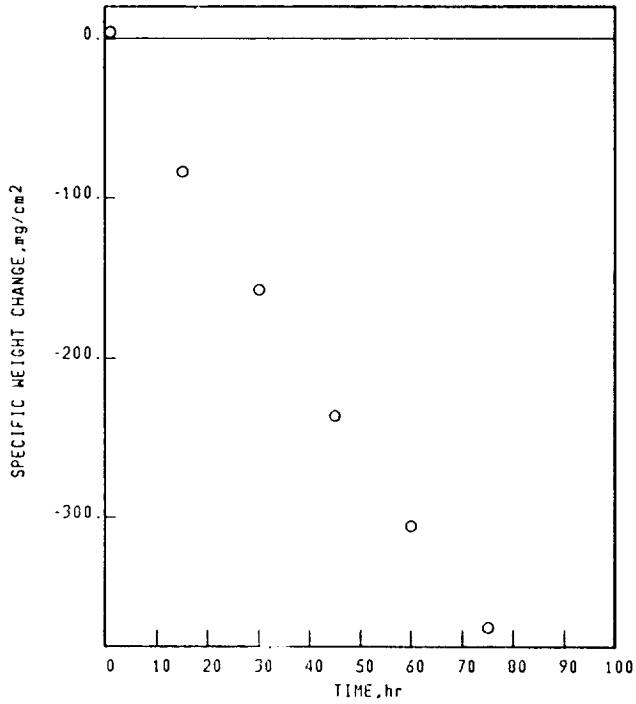
FACE CENTERED CUBIC MATRIX

SPALL
75 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-008-225-2

MAR-M-200 1150°C 1.00hr CYCLES 75.00hr TEST 2.155mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	4.02
15.00	-83.62
30.00	-157.55
45.00	-235.95
60.00	-305.41
75.00	-368.19

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-008-225-2

MAR-M-200 1150°C 1.00hr CYCLES 75.00hr TEST 2.155mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
75 hr
STANDARD SURFACE
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.10A.
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.

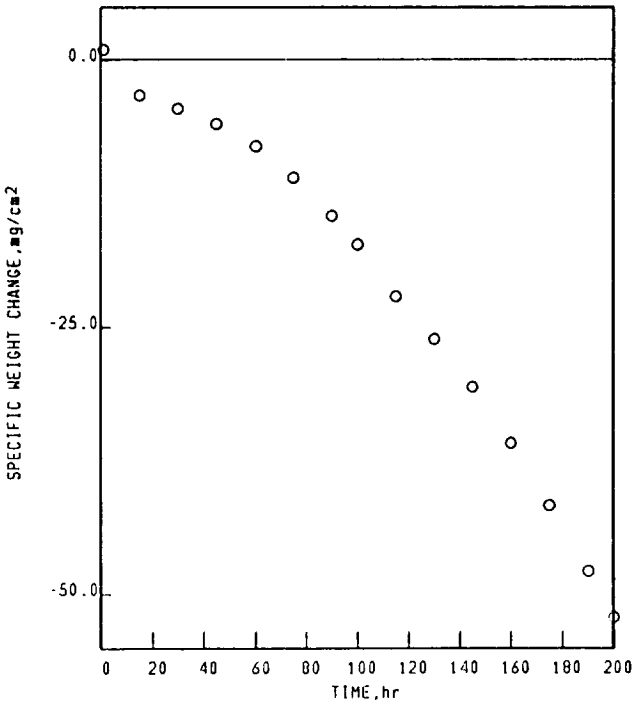
SPALL
75 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-008-310-3

MAR-M-200 1100°C 1.00hr CYCLES 200.00hr TEST 2.297mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.95
15.00	-3.31
30.00	-4.58
45.00	-6.03
60.00	-8.14
75.00	-11.11
90.00	-14.67
100.00	-17.35
115.00	-22.12
130.00	-26.13
145.00	-30.62
160.00	-35.94
175.00	-41.78
190.00	-47.82
200.00	-52.16

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-008-310-3

MAR-M-200 1100°C 1.00hr CYCLES 200.00hr TEST 2.297mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.10A.
SPINEL, a_0=8.25A.
$Ni(W,Mo)O_4$ TYPE 1
TRI(RUTILE), d(110)≤3.30A.
$NiTiO_3$
Al_2O_3

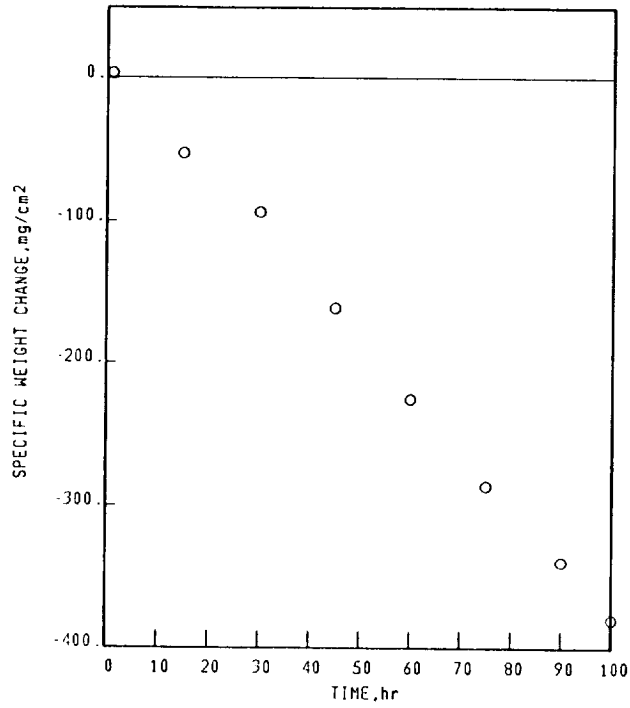
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.25A.
TRI(RUTILE), d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-009-225-3

MAR-M-200+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.304mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	3.00
15.00	-52.50
30.00	-93.81
45.00	-161.89
60.00	-225.10
75.00	-285.87
90.00	-339.84
100.00	-380.35

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-009-225-3

MAR-M-200+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.304mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.10A.
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
HfO_2

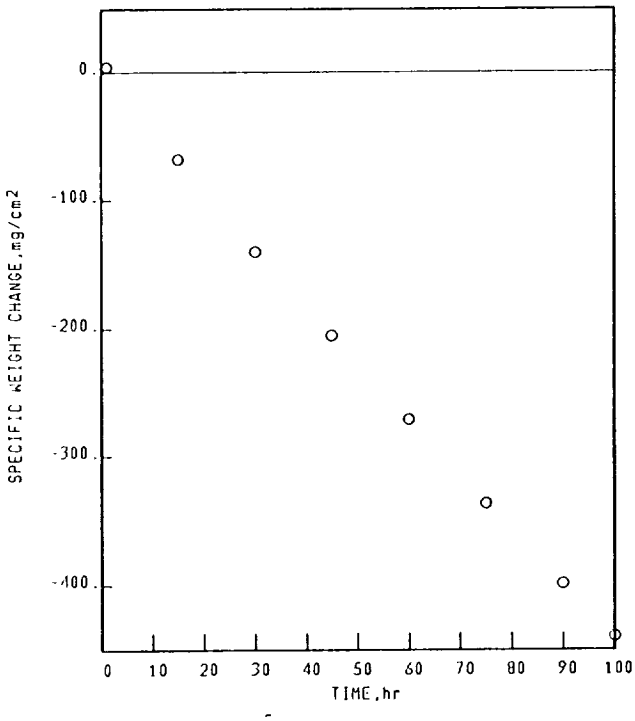
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
HfO_2

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-009-225-6

MAR-M-200+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.304mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	3.95
15.00	-68.25
30.00	-139.76
45.00	-205.30
60.00	-271.22
75.00	-336.73
90.00	-398.75
100.00	-439.85

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-009-225-6

MAR-M-200+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.304mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.10A.
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
HfO_2

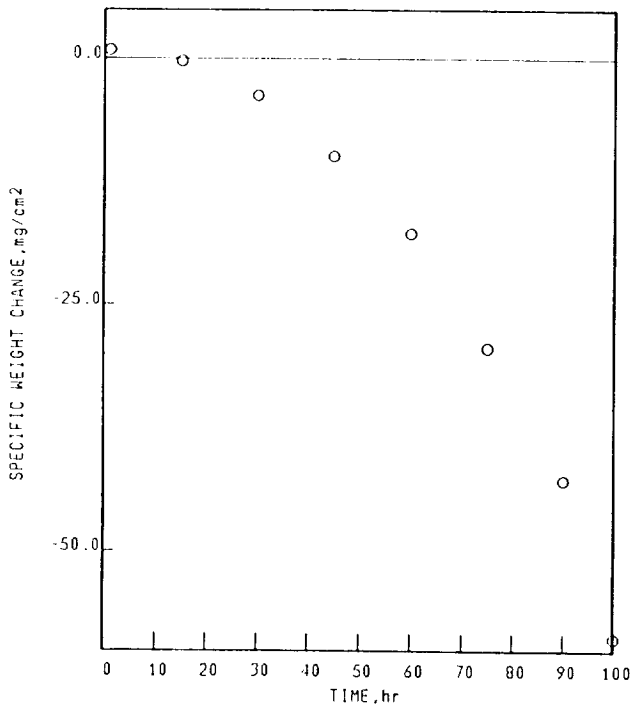
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
HfO_2

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-010-225-4

DS-MAR-M-200+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.290mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.82
15.00	-0.26
30.00	-3.69
45.00	-9.83
60.00	-17.74
75.00	-29.34
90.00	-42.71
100.00	-58.81

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-010-225-4

DS-MAR-M-200+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.290mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.10A.
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
HfO_2

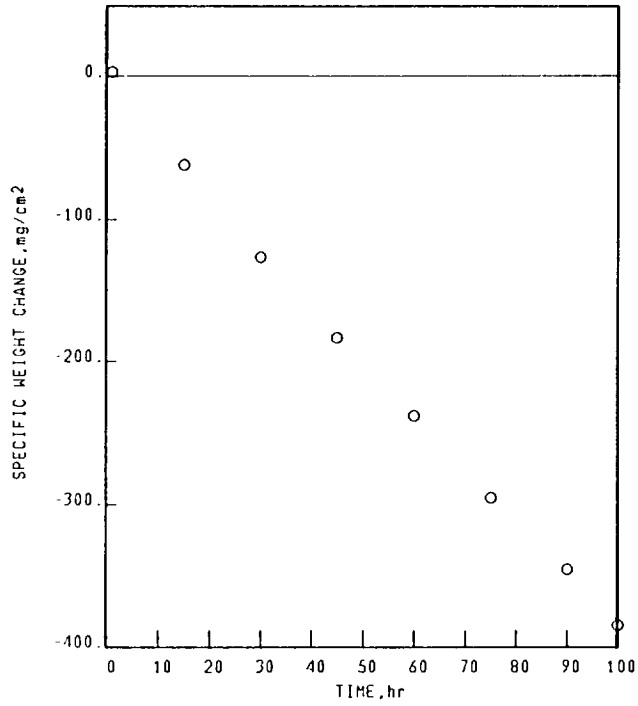
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
HfO_2

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-010-225-S

DS-MAR-M-200+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.297mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	2.93
15.00	-61.71
30.00	-126.48
45.00	-183.62
60.00	-238.35
75.00	-295.26
90.00	-345.37
100.00	-385.04

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-010-225-S

DS MAR-M-200+Hf 1150°C 1.00hr CYCLES 100.00hr TEST 2.297mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.10A.
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
HfO_2

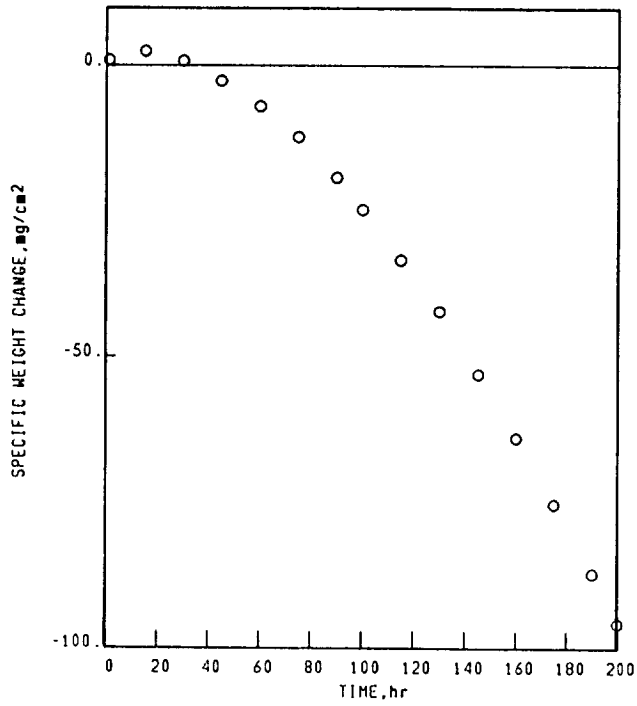
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
HfO_2

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-009-310-4

MAR-M-200+Hf 1100°C 0.03hr CYCLES 200.00hr TEST 2.300mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.93
15.00	2.46
30.00	0.78
45.00	-2.64
60.00	-7.00
75.00	-12.32
90.00	-19.32
100.00	-24.86
115.00	-33.55
130.00	-42.17
145.00	-53.01
160.00	-64.08
175.00	-75.43
190.00	-87.23
200.00	-95.85

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-009-310-4

MAR-M-200+Hf 1100°C 0.03hr CYCLES 200.00hr TEST 2.300mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.25A.
SPINEL, a_0=8.10A.
$Ni(W,Mo)O_4$ TYPE 1
TRI(RUTILE),d(110)≤3.30A.
HfO_2

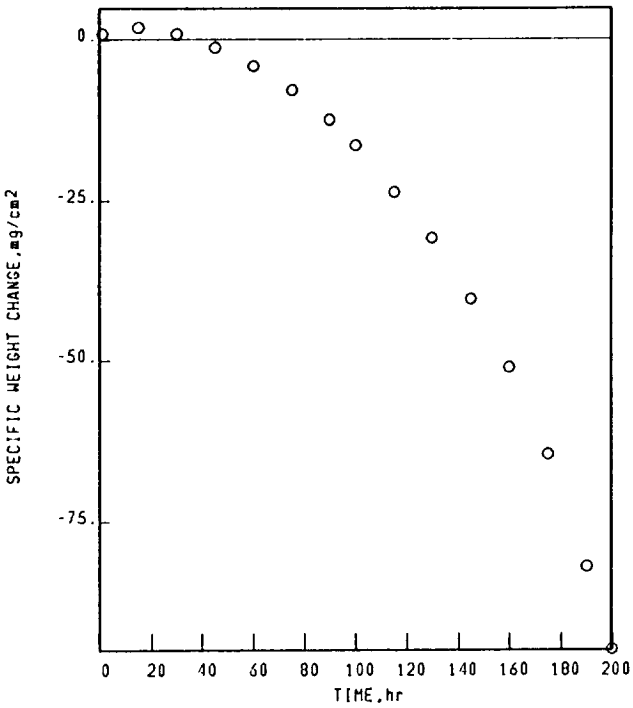
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
HfO_2

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-010-310-S

DS-MAR-M-200+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.324mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.91
15.00	1.90
30.00	0.89
45.00	-1.25
60.00	-4.16
75.00	-7.91
90.00	-12.42
100.00	-16.39
115.00	-23.72
130.00	-30.95
145.00	-40.48
160.00	-51.12
175.00	-64.49
190.00	-82.11
200.00	-94.95

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-010-310-S

DS-MAR-M-200+Hf 1100°C 1.00hr CYCLES 200.00hr TEST 2.324mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.10A.
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
HfO_2

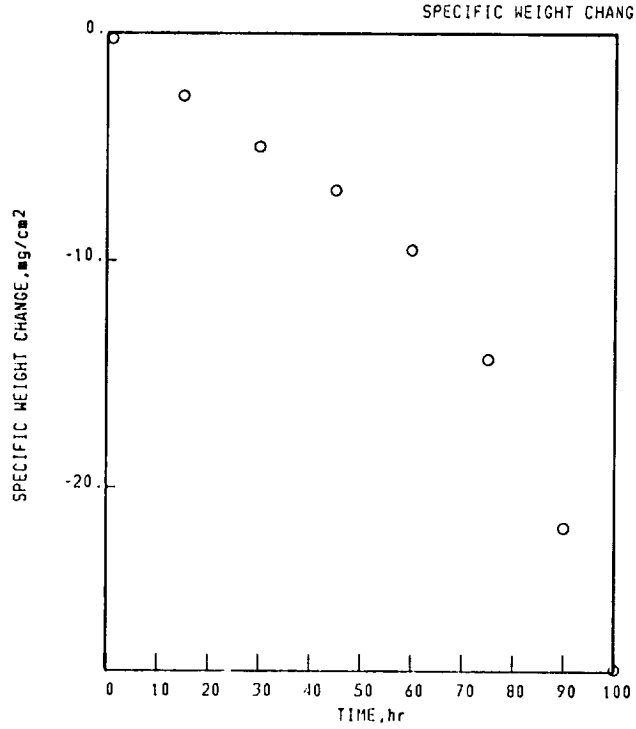
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
HfO_2

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-011-321-4

MAR-M-211 1150°C 1.00hr CYCLES 100.00hr TEST 2.248mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	-0.26
15.00	-2.79
30.00	-5.04
45.00	-6.95
60.00	-9.54
75.00	-14.33
90.00	-21.73
100.00	-27.93

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-011-321-4

MAR-M-211 1150°C 1.00hr CYCLES 100.00hr TEST 2.248mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
TRI(RUTILE),d(110)<3.30A.
Al_2O_3

FACE CENTERED CUBIC MATRIX

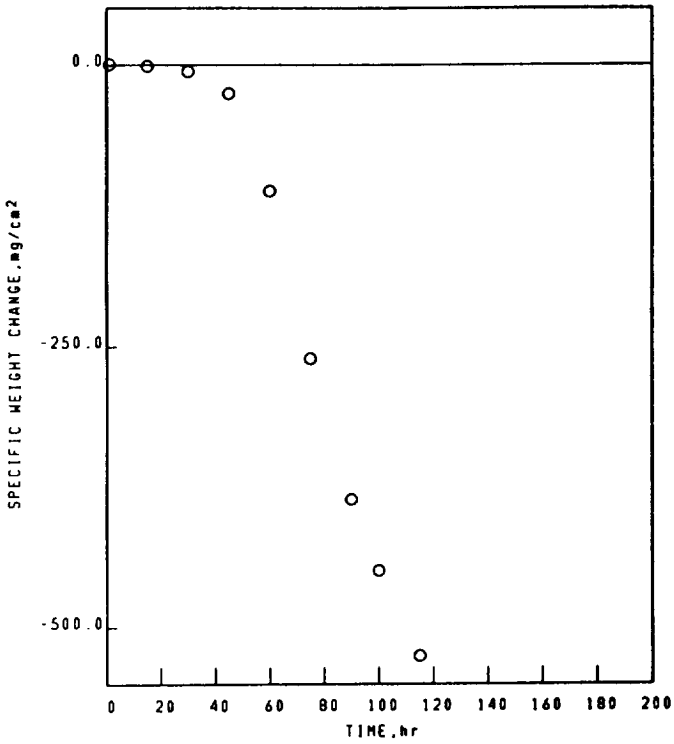
SPALL
100 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)>3.30A.

UNKNOWN LINES, d VALUES
2.76A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-011-324-4

MAR-M-211 1100°C 1.00hr CYCLES 115.00hr TEST 2.268mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.69
15.00	-0.77
30.00	-5.54
45.00	-24.83
60.00	-111.77
75.00	-260.46
90.00	-386.49
100.00	-449.99
115.00	-524.89

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-011-324-4

MAR-M-211 1100°C 1.00hr CYCLES 115.00hr TEST 2.268mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
- 200 hr
- STANDARD SURFACE
  - $Ni(W,Mo)O_4$ TYPE 1
  - SPINEL, a_0=8.05A.
  - SPINEL, a_0=8.25A.
  - TRI(RUTILE), d(110)≤3.30A.
  - NiO

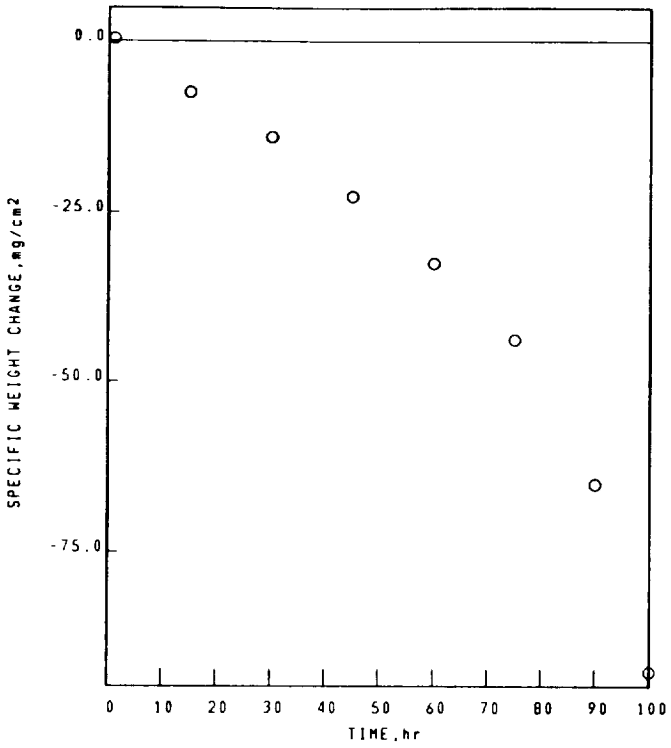
FACE CENTERED CUBIC MATRIX

SPALL
- 200 hr
- COLLECTED SPALL
  - NiO
  - $Ni(W,Mo)O_4$ TYPE 1
  - SPINEL, a_0=8.25A.
  - SPINEL, a_0=8.10A.
  - $Ni(W,Mo)O_4$ TYPE 2
  - TRI(RUTILE), d(110)>3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-012-322-3

MAR-M-246 1150°C 1.00hr CYCLES 100.00hr TEST 2.238mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm^2
0.00	0.00
1.00	0.38
15.00	-7.55
30.00	-14.10
45.00	-22.73
60.00	-32.57
75.00	-43.87
90.00	-65.03
100.00	-92.89

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-012-322-3

MAR-M-246 1150°C 1.00hr CYCLES 100.00hr TEST 2.238mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.25A.
TRI(RUTILE), d(110)≤3.30A.
SPINEL, a_0=8.10A.
Al_2O_3
Cr_2O_3

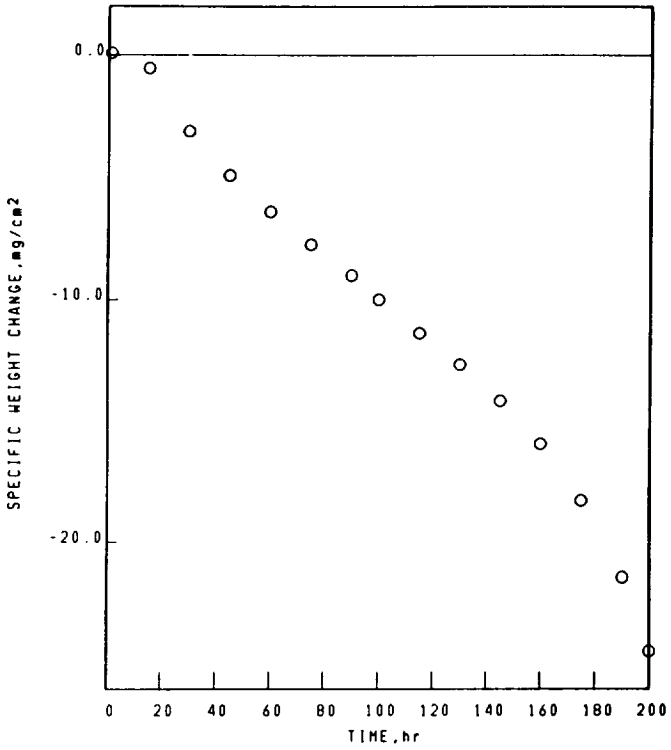
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.
SPINEL, a_0=8.05A.
TRI(RUTILE), d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-012-325-3

MAR-M-246 1100°C 1.00hr CYCLES 200.00hr TEST 2.249mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.09
15.00	-0.53
30.00	-3.12
45.00	-4.95
60.00	-6.44
75.00	-7.80
90.00	-9.05
100.00	-10.02
115.00	-11.39
130.00	-12.67
145.00	-14.18
160.00	-15.97
175.00	-18.29
190.00	-21.42
200.00	-24.44

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-012-325-3

MAR-M-246 1100°C 1.00hr CYCLES 200.00hr TEST 2.249mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
NiO
SPINEL, a_0=8.25A.
TRI(RUTILE),d(110)≤3.30A.
Cr_2O_3

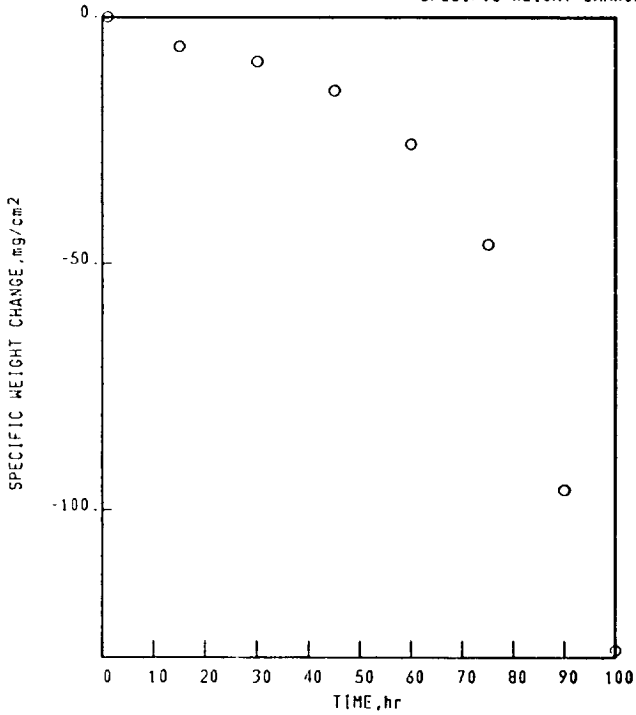
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
TRI(RUTILE),d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-013-322-1

MAR-M-421 1150°C 1.00hr CYCLES 100.00hr TEST 2.181mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	-0.06
15.00	-6.03
30.00	-9.05
45.00	-14.93
60.00	-25.64
75.00	-46.09
90.00	-95.81
100.00	-128.66

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-013-322-1

MAR-M-421 1150°C 1.00hr CYCLES 100.00hr TEST 2.181mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
TRI(RUTILE),d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

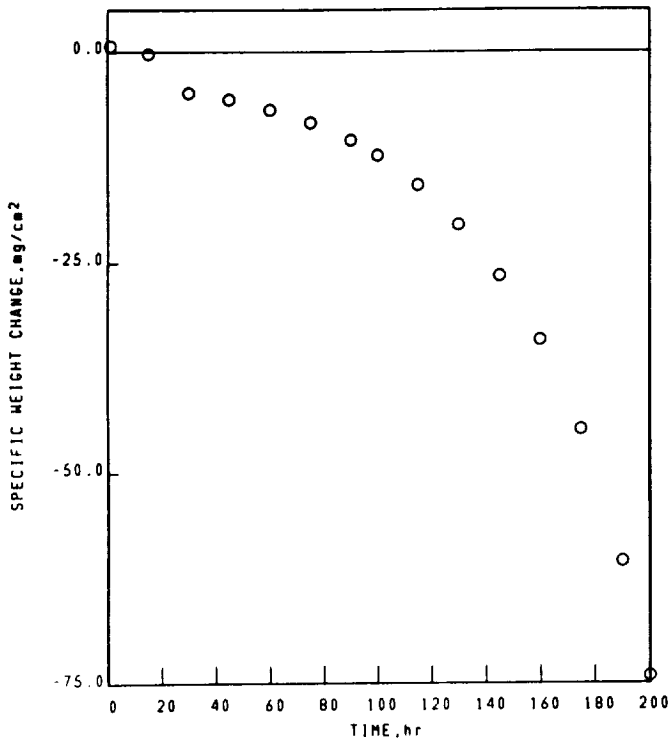
SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
$Ni(W,Mo)O_4$ TYPE 1
TRI(RUTILE),d(110)≤3.30A.
Cr_2O_3

UNKNOWN LINES, d VALUES
2.76A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-013-325-1

MAR-M-421 1100°C 1.00hr CYCLES 200.00hr TEST 2.183mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.68
15.00	-0.27
30.00	-4.90
45.00	-5.70
60.00	-6.90
75.00	-8.46
90.00	-10.54
100.00	-12.35
115.00	-15.85
130.00	-20.49
145.00	-26.58
160.00	-34.25
175.00	-44.94
190.00	-60.43
200.00	-74.11

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-013-325-1

MAR-M-421 1100°C 1.00hr CYCLES 200.00hr TEST 2.183mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
TRI(RUTILE), d(110)≤3.30A.
$Ni(W,Mo)O_4$ TYPE 1

FACE CENTERED CUBIC MATRIX

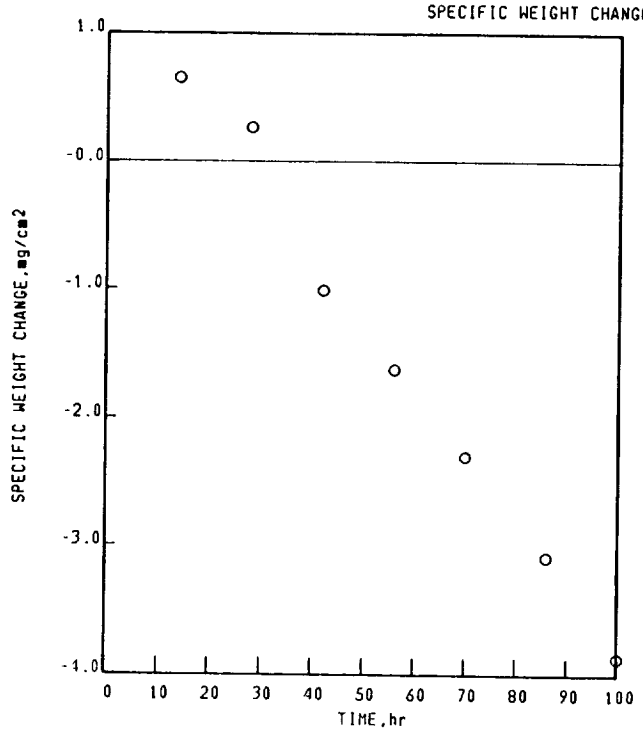
SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.
$Ni(W,Mo)O_4$ TYPE 1
TRI(RUTILE), d(110)≤3.30A.
Cr_2O_3

UNKNOWN LINES, d VALUES
2.72A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-041-3

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
14.00	0.65
28.00	0.26
42.00	-1.01
56.00	-1.62
70.00	-2.30
86.00	-3.09
100.00	-3.87

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-041-3

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.15A.
Al_2O_3

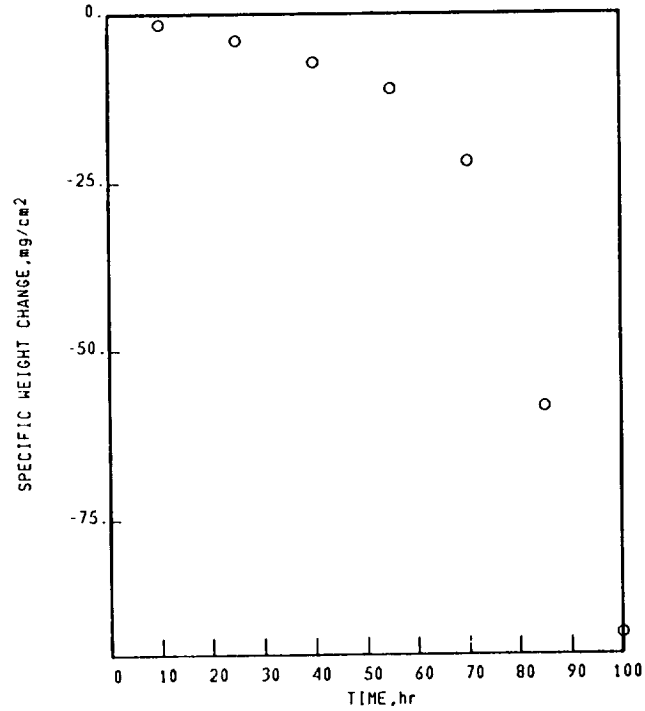
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.15A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-078-3

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 6.400mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
10.00	-1.58
25.00	-4.06
40.00	-7.33
55.00	-11.26
70.00	-22.05
85.00	-58.43
100.00	-91.95

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-078-3

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 6.400mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
TRI(RUTILE),d(110)≤3.30A.
NiO
SPINEL, a_0=8.10A.
ZrO_2

FACE CENTERED CUBIC MATRIX

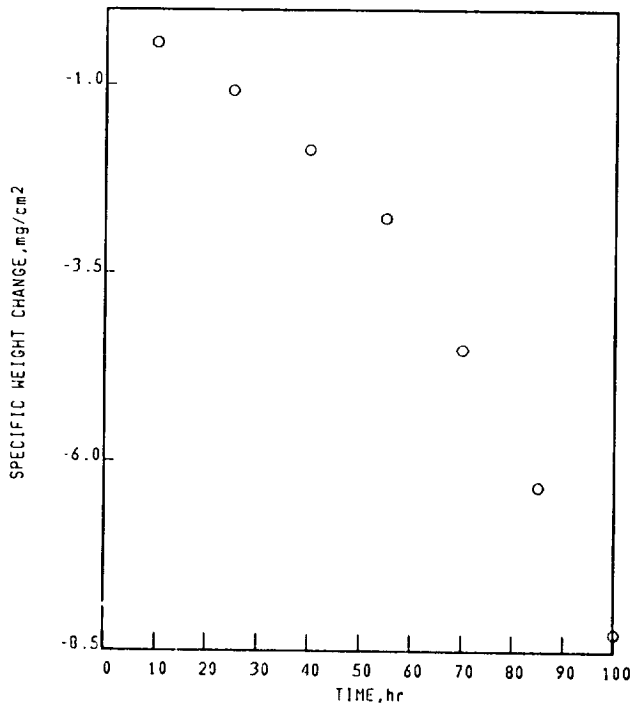
SPALL
100 hr
COLLECTED SPALL
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

UNKNOWN LINES, d VALUES
3.13A.
2.87A.
0.90A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-078-6

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 6.530mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
10.00	-0.44
25.00	-1.08
40.00	-1.87
55.00	-2.78
70.00	-4.50
85.00	-6.33
100.00	-8.27

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-078-6

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 6.530mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.10A.
Al_2O_3
ZrO_2
NiO

FACE CENTERED CUBIC MATRIX

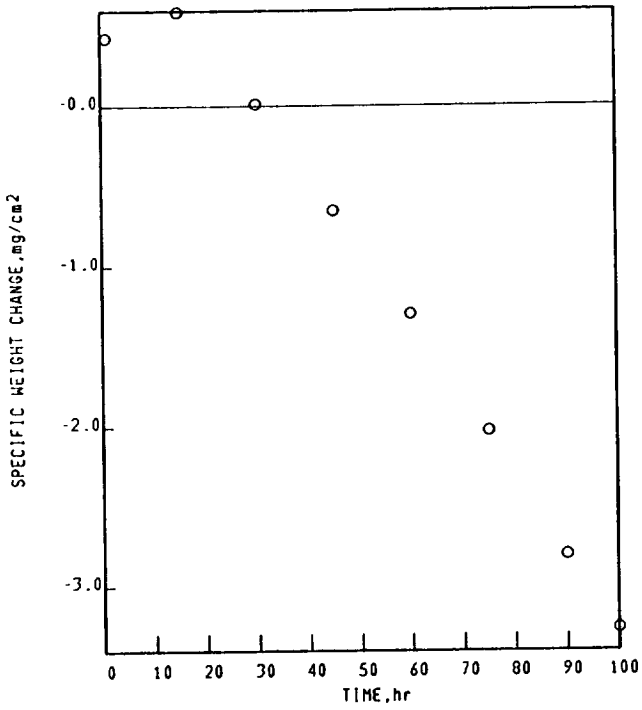
SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)≤3.30A.
TRI(RUTILE),d(110)>3.30A.
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.05A.

UNKNOWN LINES, d VALUES
2.91A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-101-4

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 2.787mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.43
15.00	0.59
30.00	0.01
45.00	-0.65
60.00	-1.30
75.00	-2.03
90.00	-2.80
100.00	-3.26

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-101-4

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 2.787mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.15A.

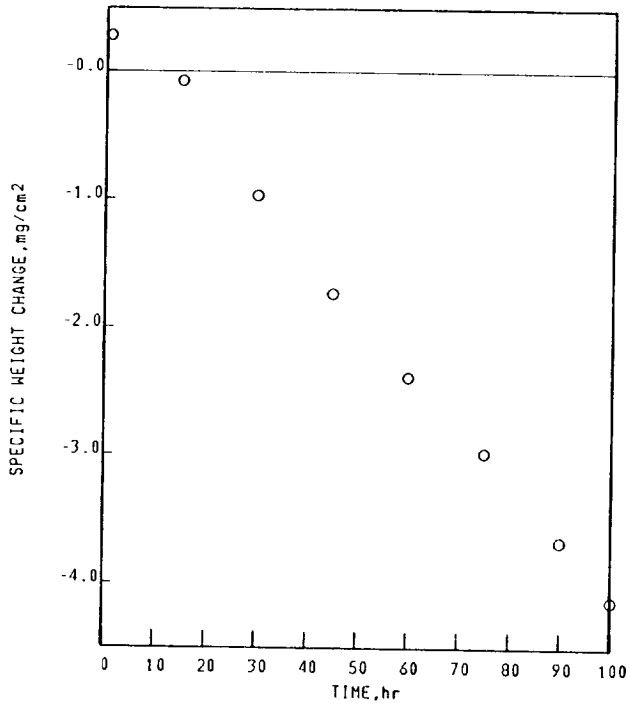
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
TRI(RUTILE),d(110)>3.30A.
TRI(RUTILE),d(110)≤3.30A.
NiO
SPINEL, a_0=8.05A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-101-S

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 2.690mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

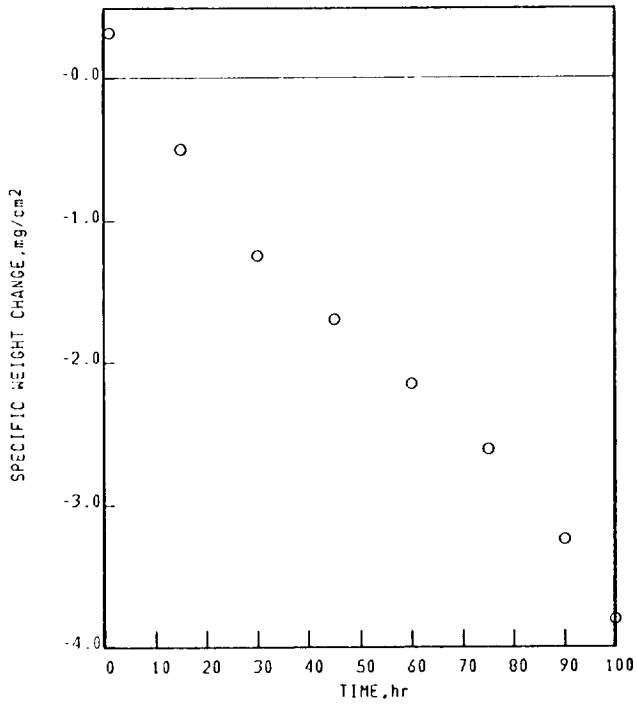


TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.28
15.00	-0.08
30.00	-0.97
45.00	-1.73
60.00	-2.39
75.00	-2.98
90.00	-3.66
100.00	-4.13

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-129-1

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 1.150mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

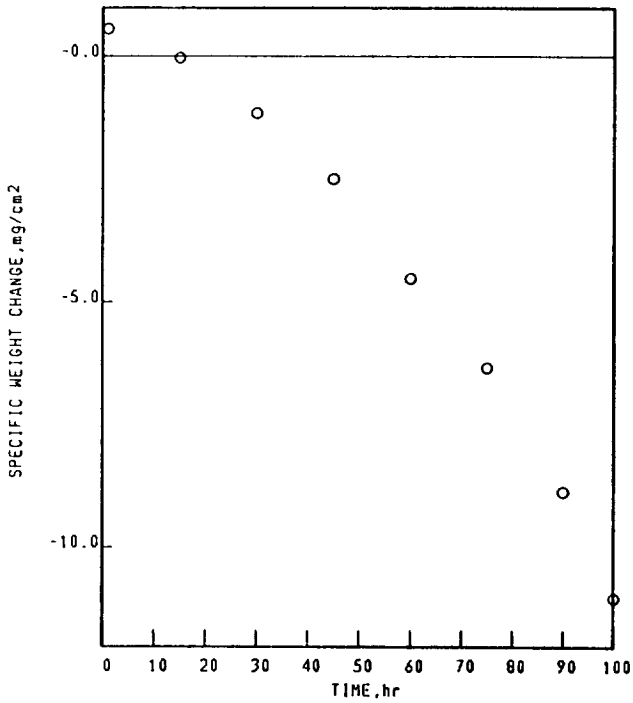


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.32
15.00	-0.50
30.00	-1.25
45.00	-1.70
60.00	-2.15
75.00	-2.61
90.00	-3.24
100.00	-3.81

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-129-3

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 2.291mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

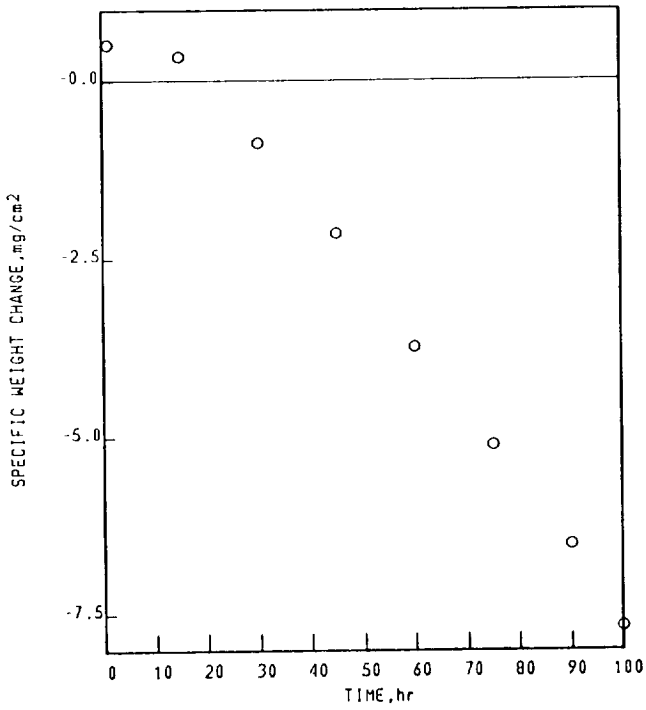


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.56
15.00	-0.04
30.00	-1.17
45.00	-2.52
60.00	-4.52
75.00	-6.33
90.00	-8.87
100.00	-11.01

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-129-4

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 2.293mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

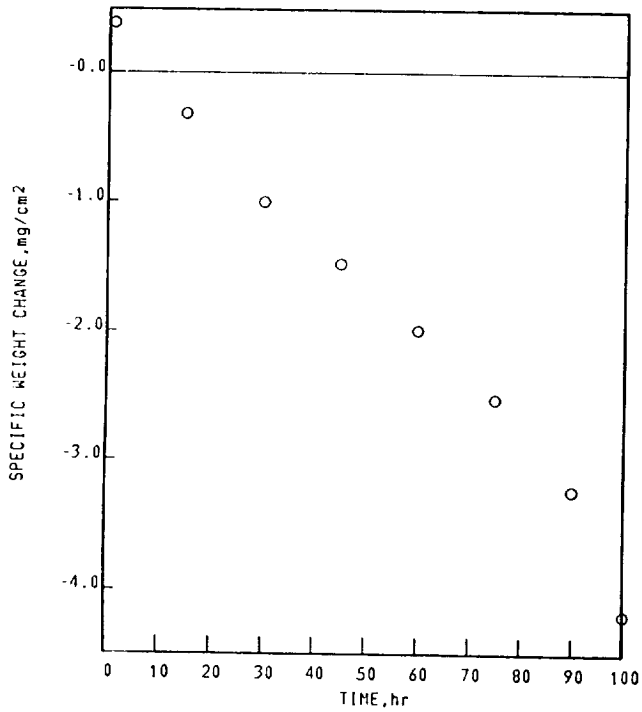


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.51
15.00	0.34
30.00	-0.86
45.00	-2.13
60.00	-3.75
75.00	-5.11
90.00	-6.52
100.00	-7.68

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-129-5

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 1.149mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.39
15.00	-0.32
30.00	-1.01
45.00	-1.48
60.00	-1.99
75.00	-2.53
90.00	-3.23
100.00	-4.20

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-129-5

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 1.149mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3
ZrO_2

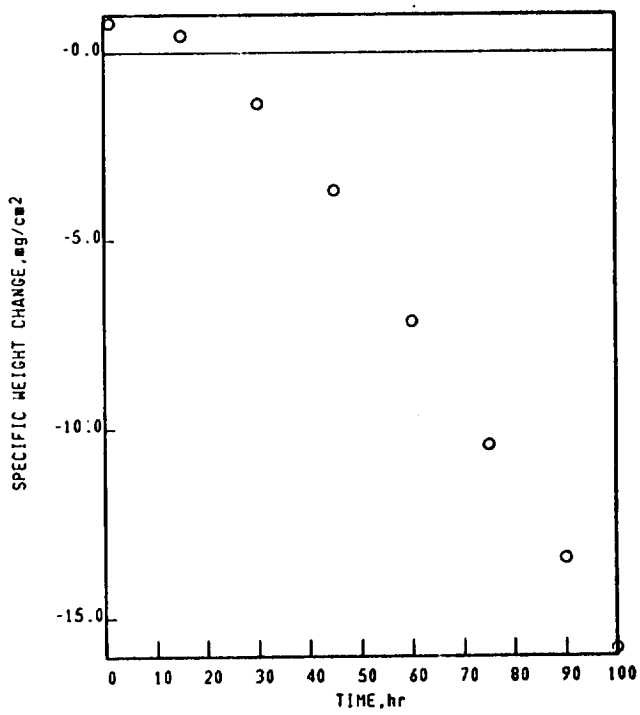
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)≤3.30A.
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.10A.
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-129-6

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 2.292mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.76
15.00	0.45
30.00	-1.36
45.00	-3.68
60.00	-7.16
75.00	-10.44
90.00	-13.45
100.00	-15.81

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-129-6

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 2.292mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3
ZrO_2

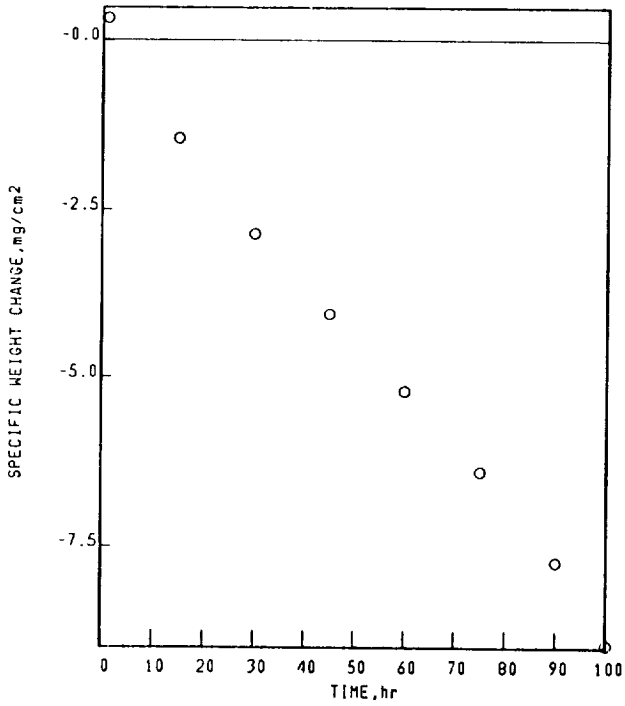
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)≤3.30A.
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.10A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-204-5

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 2.754mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.33
15.00	-1.45
30.00	-2.86
45.00	-4.06
60.00	-5.20
75.00	-6.38
90.00	-7.72
100.00	-8.96

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-204-5

NASA-TRW-VI-A 1150°C 1.00hr CYCLES 100.00hr TEST 2.754mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
Cr_2O_3
Al_2O_3

FACE CENTERED CUBIC MATRIX

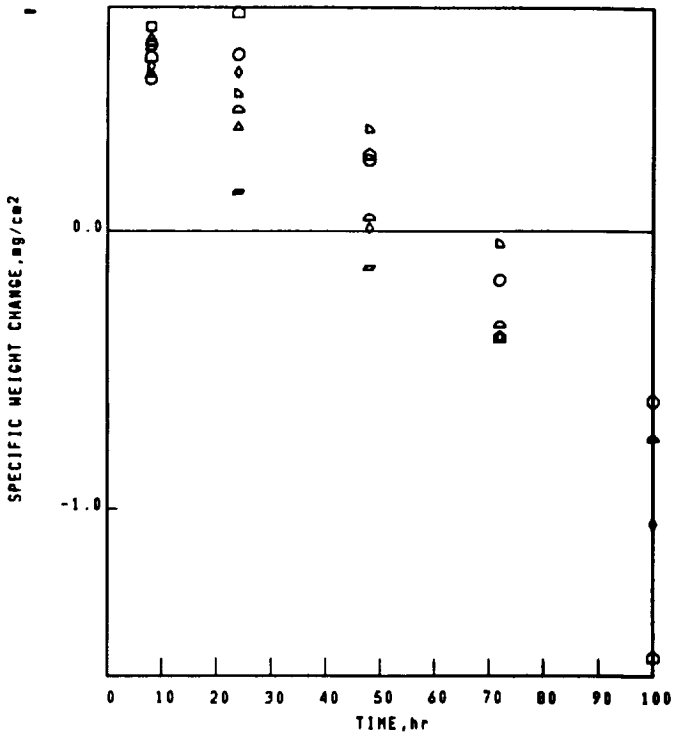
SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)>3.30A.
TRI(RUTILE),d(110)≤3.30A.

UNKNOWN LINES, d VALUES
1.43A.
1.38A.
1.06A.

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-001-6

NASA-TRW-VI-A 1100°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR(TM D-7484)

SPECIFIC WEIGHT CHANGE DATA



○ 02-04-021-001-6
□ 02-04-021-001-1
△ 02-04-021-001-2
▫ 02-04-021-001-3
▷ 02-04 021-001-4
⌂ 02-04-021-001-5
◇ 02-04-021-010-4
⌂ 02-04-021-010-5

TIME,hr	ΔW/A,mg/cm²
0.00	0.00
8.00	0.54
24.00	0.63
48.00	0.25
72.00	-0.18
100.00	-0.61

TIME,hr	ΔW/A,mg/cm² 001-1
0.00	0.00
8.00	0.73

TIME,hr	ΔW/A,mg/cm² 001-2
0.00	0.00
8.00	0.69
24.00	0.37

TIME,hr	ΔW/A,mg/cm² 001-3
0.00	0.00
8.00	0.65
24.00	0.14
48.00	-0.13

TIME,hr	ΔW/A,mg/cm² 001-4
0.00	0.00
8.00	0.56
24.00	0.49
46.00	0.36
72.00	-0.05

TIME,hr	ΔW/A,mg/cm² 001-5
0.00	0.00
8.00	0.67
24.00	0.44
48.00	0.05
72.00	-0.34
100.00	-0.74

TIME,hr	ΔW/A,mg/cm² 010-4
0.00	0.00
8.00	0.59
24.00	0.57
48.00	0.01
72.00	-0.38
100.00	-1.05

TIME,hr	ΔW/A,mg/cm² 010-5
0.00	0.00
8.00	0.62
24.00	0.78
48.00	0.28
72.00	-0.38
100.00	-1.53

X-RAY DIFFRACTION DATA

SURFACE
8 hr
STANDARD SURFACE
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3
SPINEL, a_0=8.10A.
SPINEL, a_0=8.30A.

FACE CENTERED CUBIC MATRIX

SPALL
8 hr
NO SIGNIFICANT SPALL OBSERVED 001-1

SURFACE
100 hr
STANDARD SURFACE
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.10A.
Al_2O_3

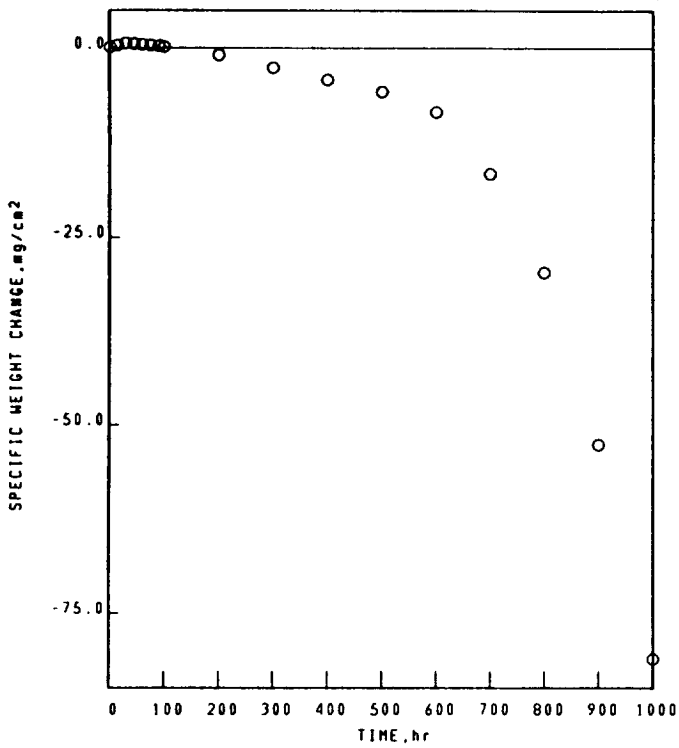
FACE CENTERED CUBIC MATRIX

SPALL 001-5
100 hr
COLLECTED SPALL
TRI(RUTILE),d(110)≤3.30A.
Cr_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-103-1

NASA-TRW-VI-A 1100°C 1.00hr CYCLES 1000.00hr TEST 6.240mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.15
15.00	0.40
30.00	0.66
45.00	0.57
60.00	0.47
75.00	0.37
90.00	0.27
100.00	0.18
200.00	-0.94
300.00	-2.56
400.00	-4.18
500.00	-5.83
600.00	-8.53
700.00	-16.76
800.00	-29.72
900.00	-52.64
1000.00	-81.11

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-103-1

NASA-TRW-VI-A 1100°C 1.00hr CYCLES 1000.00hr TEST 6.240mm THICK STATIC AIR

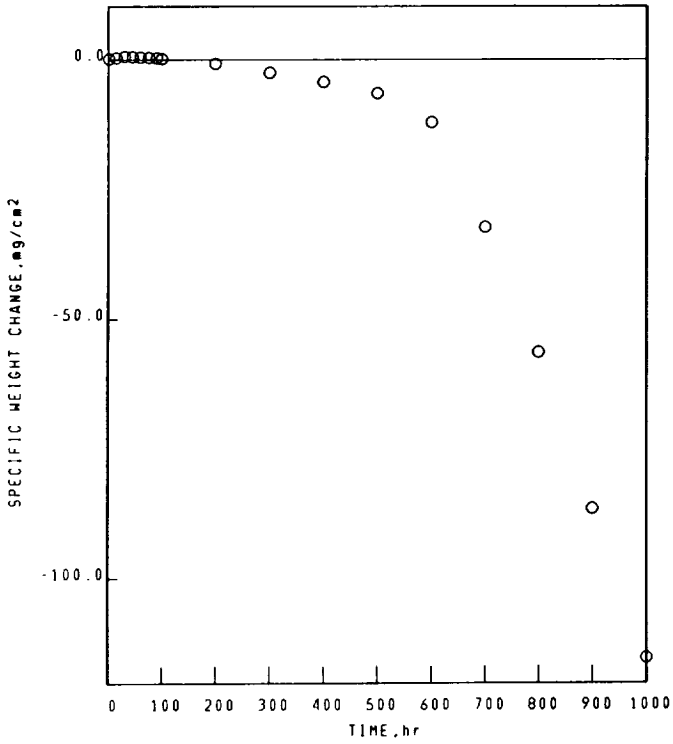
X-RAY DIFFRACTION DATA

SURFACE	SPALL
500 hr	500 hr
SURFACE NOT SATISFACTORY-NO XRD	COLLECTED SPALL
	TRI(RUTILE), d(110)>3.30A.
	TRI(RUTILE), d(110)≤3.30A.
	NiO
	SPINEL, a_0=8.20A.
600 hr	600 hr
SURFACE NOT SATISFACTORY-NO XRD	COLLECTED SPALL
	NiO
	TRI(RUTILE), d(110)≤3.30A.
	TRI(RUTILE), d(110)≤3.30A.
	SPINEL, a_0=8.15A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-103-2

NASA-TRW-VI-A 1100°C 1.00hr CYCLES 1000.00hr TEST 6.240mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.12
15.00	0.34
30.00	0.61
45.00	0.53
60.00	0.45
75.00	0.40
90.00	0.31
100.00	0.19
200.00	-0.77
300.00	-2.49
400.00	-4.32
500.00	-6.51
600.00	-12.13
700.00	-32.45
800.00	-56.37
900.00	-86.57
1000.00	-115.12

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-103-2

NASA-TRW-VI-A 1100°C 1.00hr CYCLES 1000.00hr TEST 6.240mm THICK STATIC AIR

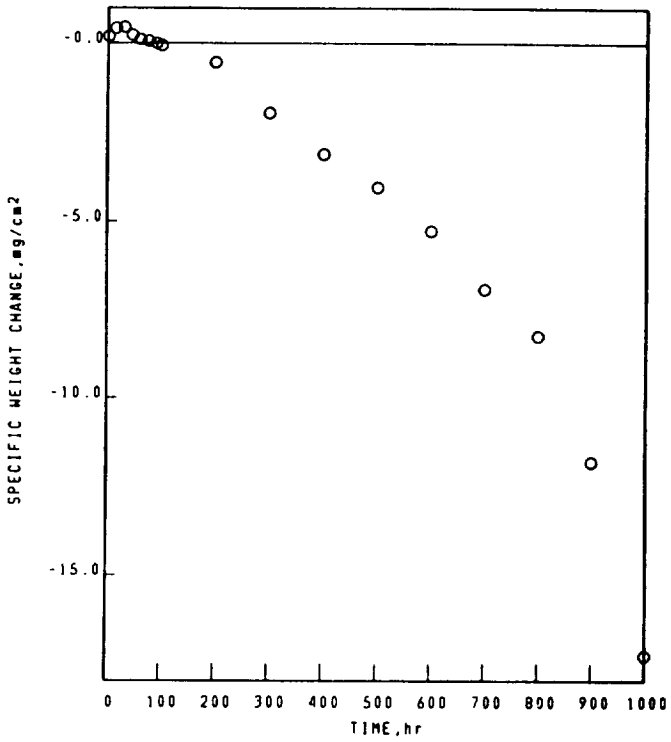
X-RAY DIFFRACTION DATA

SURFACE	SPALL
500 hr	500 hr
SURFACE NOT SATISFACTORY-NO XRD	COLLECTED SPALL
	NiO
	SPINEL, a_0=8.25A.
	TRI(RUTILE), d(110)>3.30A.
600 hr	600 hr
SURFACE NOT SATISFACTORY-NO XRD	COLLECTED SPALL
	NiO
	TRI(RUTILE), d(110)>3.30A.
	SPINEL, a_0=8.15A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-103-6

NASA-TRW-VI-A 1100°C 1.00hr CYCLES 1000.00hr TEST 6.240mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.19
15.00	0.43
30.00	0.46
45.00	0.23
60.00	0.11
75.00	0.06
90.00	-0.01
100.00	-0.06
200.00	-0.54
300.00	-1.96
400.00	-3.12
500.00	-4.03
600.00	-5.26
700.00	-6.91
800.00	-8.25
900.00	-11.78
1000.00	-17.29

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-103-6

NASA-TRW-VI-A 1100°C 1.00hr CYCLES 1000.00hr TEST 6.240mm THICK STATIC AIR

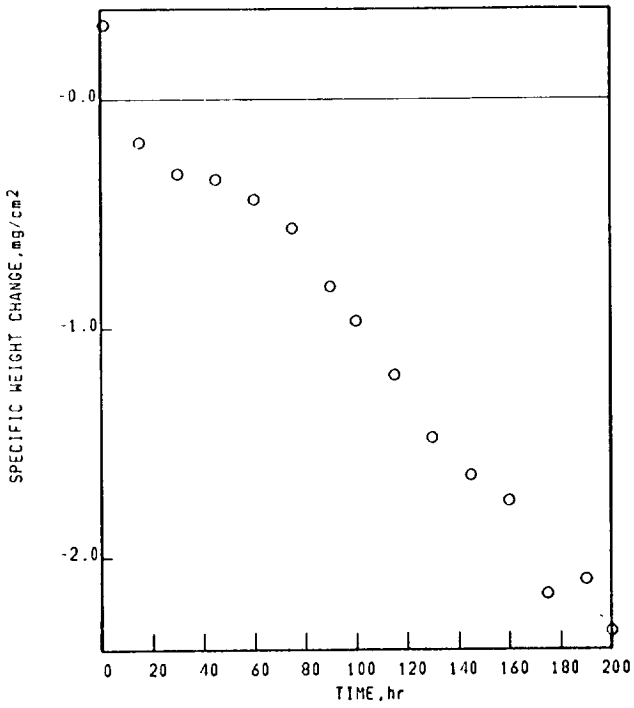
X-RAY DIFFRACTION DATA

SURFACE	SPALL
500 hr	500 hr
SURFACE NOT SATISFACTORY-NO XRD	COLLECTED SPALL
	TRI(RUTILE),d(110)≤3.30A.
	NiO
	TRI(RUTILE),d(110)≤3.30A.
	SPINEL, a_0=8.25A.
	Al_2O_3
600 hr	600 hr
SURFACE NOT SATISFACTORY-NO XRD	COLLECTED SPALL
	NiO
	TRI(RUTILE),d(110)>3.30A.
	TRI(RUTILE),d(110)≤3.30A.
	SPINEL, a_0=8.25A.
	UNKNOWN LINES, d VALUES
	1.72A.
	1.26A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-190-6

NASA-TRW-VI-A 1100°C 1.00hr CYCLES 200.00hr TEST 2.737mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.33
15.00	-0.19
30.00	-0.33
45.00	-0.35
60.00	-0.44
75.00	-0.57
90.00	-0.82
100.00	-0.97
115.00	-1.21
130.00	-1.48
145.00	-1.64
160.00	-1.76
175.00	-2.16
190.00	-2.10
200.00	-2.32

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-190-6

NASA-TRW-VI-A 1100°C 1.00hr CYCLES 200.00hr TEST 2.737mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

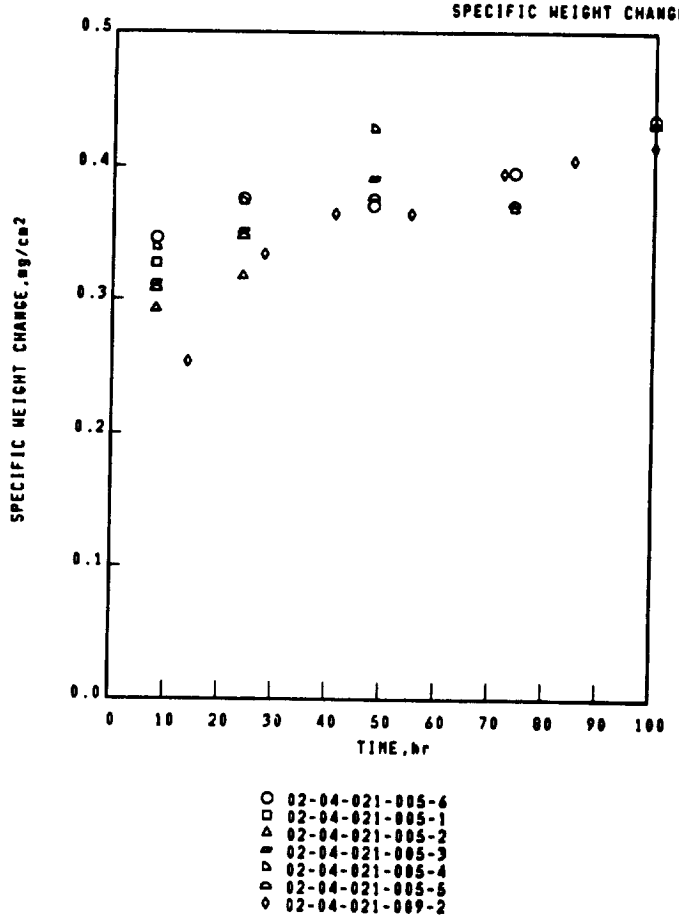
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
SPINEL, a_0=8.05A.

NI BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-021-005-6

NASA-TRW-VI-A 1000°C 1.00hr CYCLES 100.00hr TEST 6.500mm THICK STATIC AIR(TM D-7484)

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
8.00	0.35
24.00	0.38
48.00	0.37
74.00	0.40
100.00	0.44

TIME,hr	ΔW/A,mg/cm² 005-1
0.00	0.00
8.00	0.33

TIME,hr	ΔW/A,mg/cm² 005-2
0.00	0.00
8.00	0.29
24.00	0.32

TIME,hr	ΔW/A,mg/cm² 005-3
0.00	0.00
8.00	0.31
24.00	0.35
48.00	0.39

TIME,hr	ΔW/A,mg/cm² 005-4
0.00	0.00
8.00	0.34
24.00	0.37
48.00	0.43
74.00	0.37

TIME,hr	ΔW/A,mg/cm² 005-5
0.00	0.00
8.00	0.31
24.00	0.35
48.00	0.38
74.00	0.37
100.00	0.43

TIME,hr	ΔW/A,mg/cm² 009-2
0.00	0.00
14.00	0.25
28.00	0.33
41.00	0.36
72.00	0.40
100.00	0.42
55.00	0.36
85.00	0.41

X-RAY DIFFRACTION DATA

SURFACE
0 hr
STANDARD SURFACE
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3
SPINEL, a_0=8.10A.

FACE CENTERED CUBIC MATRIX

SPALL 005-1
0 hr
NO SIGNIFICANT SPALL OBSERVED

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3
SPINEL, a_0=8.10A.

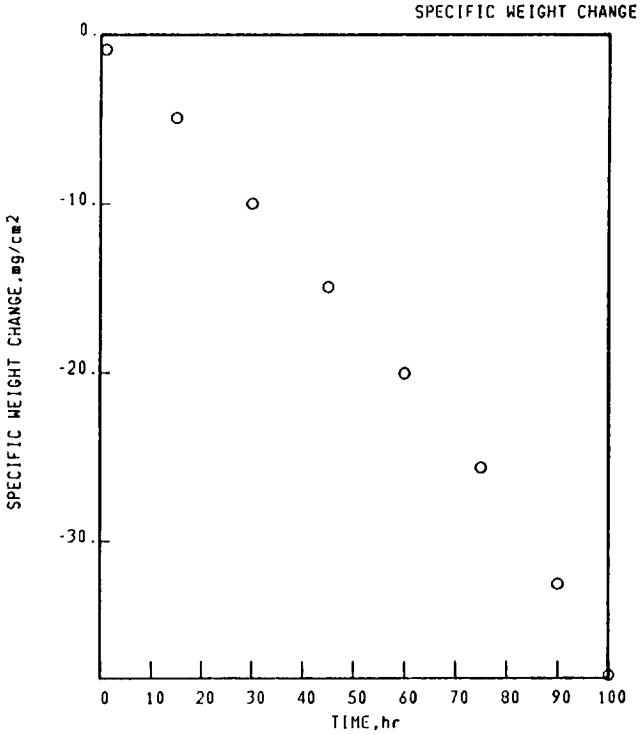
FACE CENTERED CUBIC MATRIX

SPALL 005-5
100 hr
NO SIGNIFICANT SPALL OBSERVED

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-027-102-3

NX-188 1150°C 1.00hr CYCLES 100.00hr TEST 2.632mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	-0.92
15.00	-4.91
30.00	-9.99
45.00	-14.99
60.00	-20.04
75.00	-25.61
90.00	-32.53
100.00	-37.87

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-027-102-3

NX-188 1150°C 1.00hr CYCLES 100.00hr TEST 2.632mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
NiO
SPINEL, a_0=8.10A.

FACE CENTERED CUBIC MATRIX

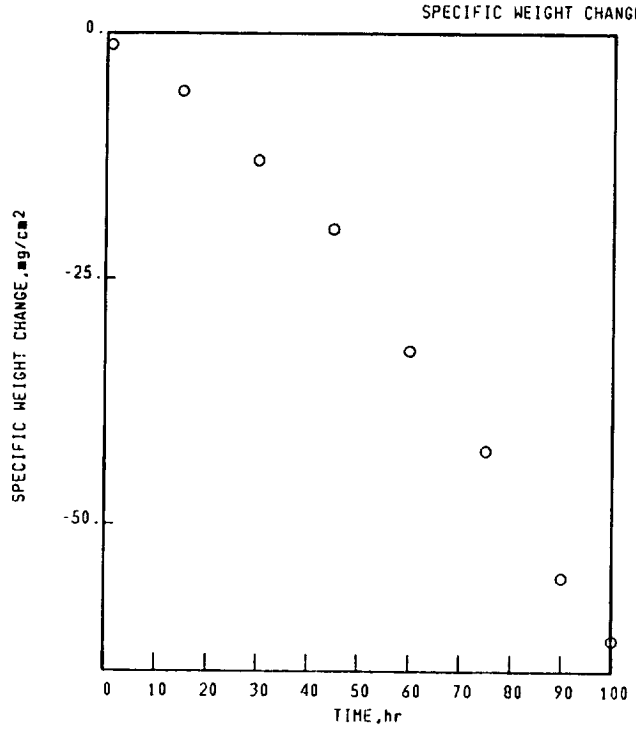
SPALL
100 hr
COLLECTED SPALL
CoO
SPINEL, a_0=8.05A.
SPINEL, a_0=8.25A.

UNKNOWN LINES, d VALUES
2.66A.
1.60A.
0.90A.
0.80A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-027-102-6

NX-188 1150°C 1.00hr CYCLES 100.00hr TEST 2.640mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

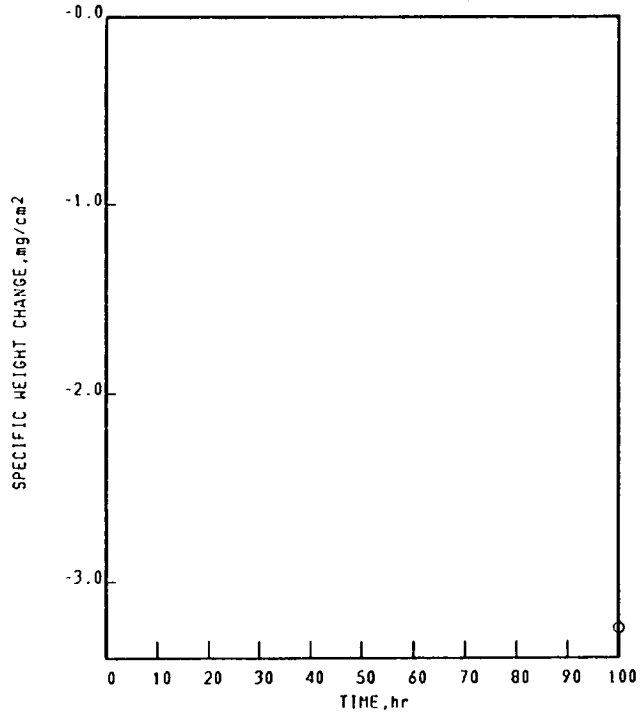


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	-1.27
15.00	-6.00
30.00	-13.07
45.00	-19.93
60.00	-32.45
75.00	-42.61
90.00	-55.42
100.00	-61.88

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-027-139-4

NX-188 1150°C 100.00hr CYCLES 100.00hr TEST 2.662mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
100.00	-3.25

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-027-139-4

NX-188 1150°C 100.00hr CYCLES 100.00hr TEST 2.662mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
NiO
Al_2O_3
SPINEL, a_0=8.05A.

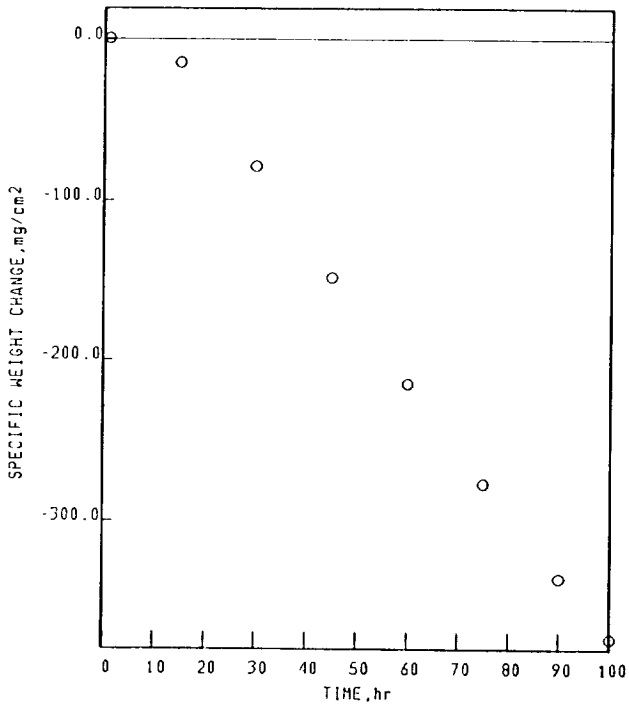
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.05A.
Al_2O_3
Ni IN SPALL

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-025-108-6

RENE 80 1150°C 1.00hr CYCLES 100.00hr TEST 1.807mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

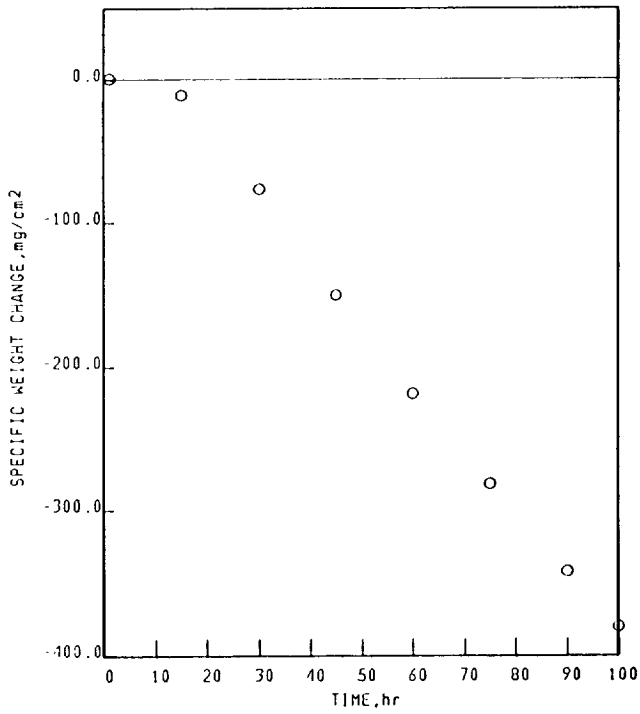


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.57
15.00	-14.61
30.00	-78.76
45.00	-148.63
60.00	-214.87
75.00	-276.58
90.00	-336.24
100.00	-373.88

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-025-108-3

RENE 80 1150°C 1.00hr CYCLES 100.00hr TEST 1.750mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.51
15.00	-11.10
30.00	-76.73
45.00	-149.77
60.00	-218.91
75.00	-281.64
90.00	-341.71
100.00	-380.00

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-025-108-3

RENE 80 1150°C 1.00hr CYCLES 100.00hr TEST 1.750mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
Cr_2O_3
NiO

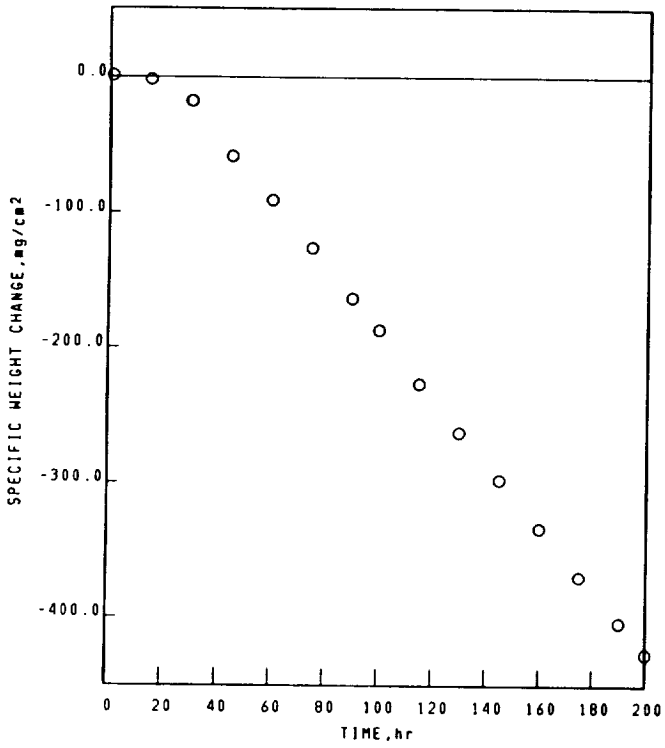
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)≤3.30A.
TRI(RUTILE),d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-025-232-3

RENE 80 1100°C 1.00hr CYCLES 200.00hr TEST 1.798mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.82
15.00	-1.81
30.00	-17.58
45.00	-58.21
60.00	-90.91
75.00	-126.57
90.00	-163.89
100.00	-187.14
115.00	-226.20
130.00	-262.37
145.00	-297.41
160.00	-333.77
175.00	-369.87
190.00	-403.87
200.00	-426.45

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-025-232-3

RENE 80 1100°C 1.00hr CYCLES 200.00hr TEST 1.798mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
Cr_2O_3
SPINEL, a_0=8.30A.
NiO

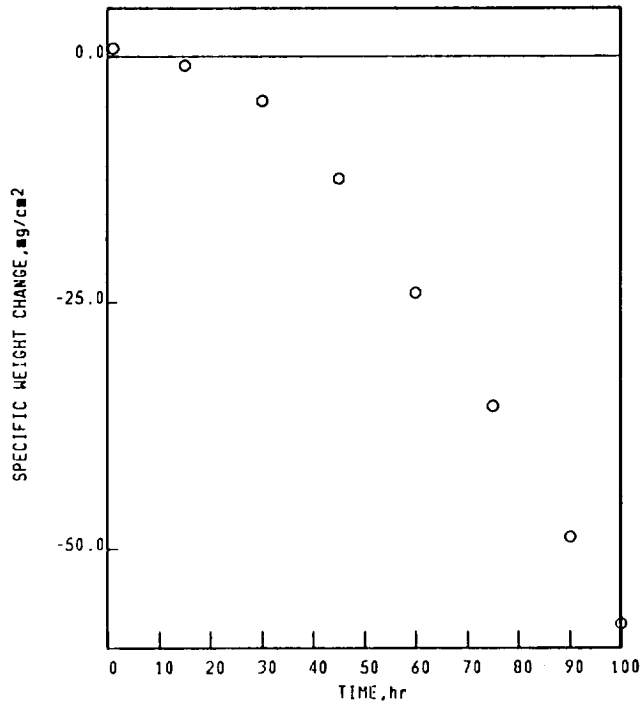
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.20A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-016-108-4

RENE 120 1150°C 1.00hr CYCLES 100.00hr TEST 0.795mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.84
15.00	-0.89
30.00	-4.53
45.00	-12.34
60.00	-24.03
75.00	-35.54
90.00	-48.77
100.00	-57.63

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-016-108-4

RENE 120 1150°C 1.00hr CYCLES 100.00hr TEST 0.795mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
TRI(RUTILE), d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

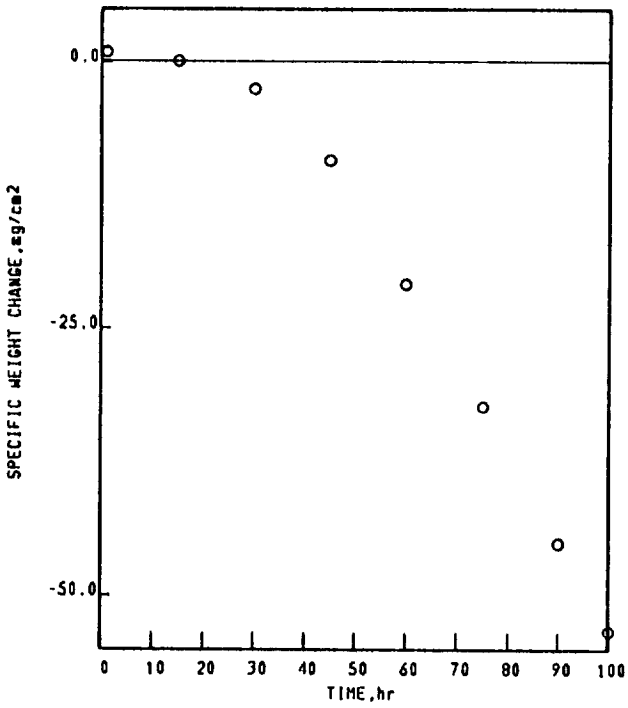
SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE), d(110)>3.30A.
TRI(RUTILE), d(110)≤3.30A.
TRI(RUTILE), d(110)≤3.30A.

UNKNOWN LINES, d VALUES
2.89A.
3.69A.
2.95A.
1.75A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-016-108-5

RENE 120 1150°C 1.00hr CYCLES 100.00hr TEST 0.733mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

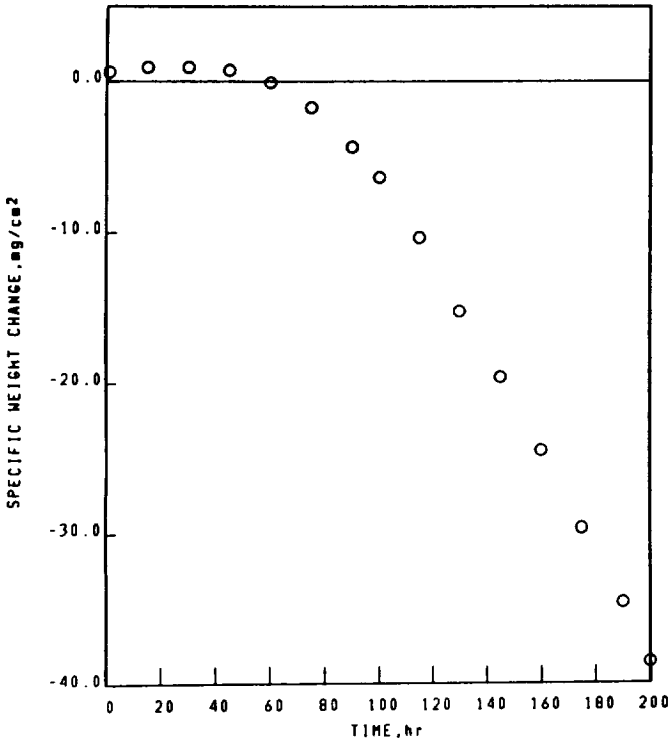


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.87
15.00	0.04
30.00	-2.59
45.00	-9.34
60.00	-20.85
75.00	-32.35
90.00	-45.07
100.00	-53.30

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-016-232-6

RENE 120 1100°C 1.00hr CYCLES 200.00hr TEST 0.800mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.64
15.00	0.96
30.00	0.96
45.00	0.76
60.00	-0.05
75.00	-1.74
90.00	-4.36
100.00	-6.38
115.00	-10.36
130.00	-15.23
145.00	-19.63
160.00	-24.54
175.00	-29.60
190.00	-34.61
200.00	-38.57

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-016-232-6

RENE 120 1100°C 1.00hr CYCLES 200.00hr TEST 0.800mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.15A.
TRI(RUTILE), d(110)≤3.30A.
Cr_2O_3

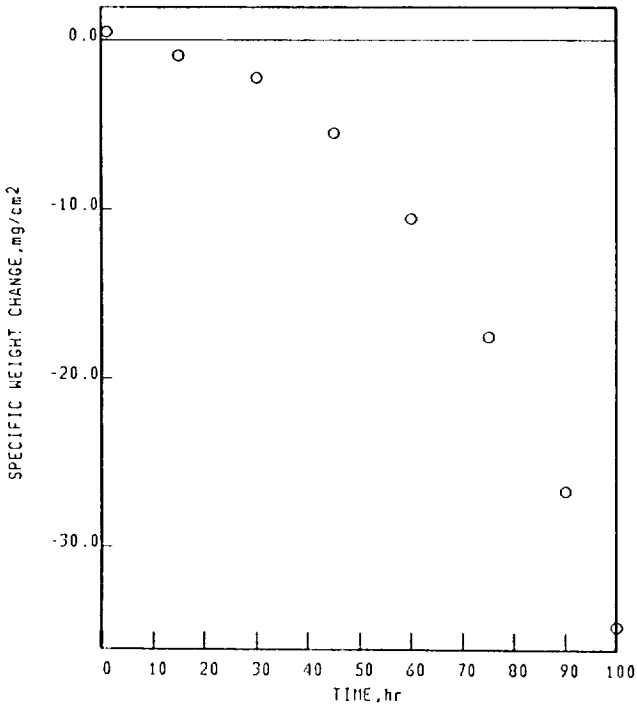
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.20A.
TRI(RUTILE), d(110)≤3.30A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-017-322-4

RENE 125 1150°C 1.00hr CYCLES 100.00hr TEST 2.340mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.48
15.00	-0.91
30.00	-2.19
45.00	-5.47
60.00	-10.55
75.00	-17.57
90.00	-26.65
100.00	-34.69

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-017-322-4

RENE 125 1150°C 1.00hr CYCLES 100.00hr TEST 2.340mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
TRI(RUTILE), d(110)≤3.30A.
SPINEL, a_0=8.25A.
Al_2O_3
HfO_2

FACE CENTERED CUBIC MATRIX

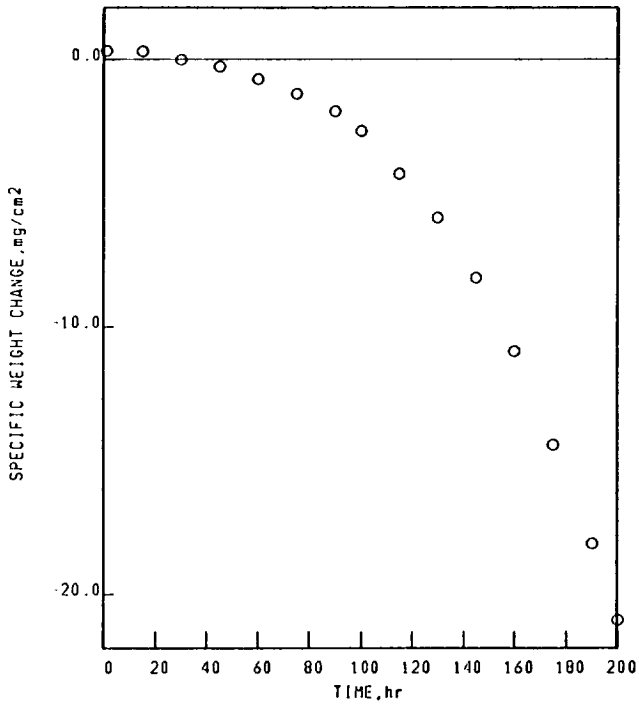
SPALL
100 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 2
SPINEL, a_0=8.30A.
TRI(RUTILE), d(110)≤3.30A.

UNKNOWN LINES, d VALUES
3.14A.
4.97A.
4.38A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-017-325-4

RENE 125 1100°C 1.00hr CYCLES 200.00hr TEST 2.341mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.33
15.00	0.31
30.00	-0.01
45.00	-0.27
60.00	-0.74
75.00	-1.29
90.00	-1.94
100.00	-2.68
115.00	-4.28
130.00	-5.90
145.00	-8.15
160.00	-10.93
175.00	-14.43
190.00	-18.09
200.00	-20.97

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-017-325-4

RENE 125 1100°C 1.00hr CYCLES 200.00hr TEST 2.341mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.25A.
SPINEL, a_0=8.10A.
TRI(RUTILE),d(110)≤3.30A.
$Ni(W,Mo)O_4$ TYPE 1
Cr_2O_3
HfO_2

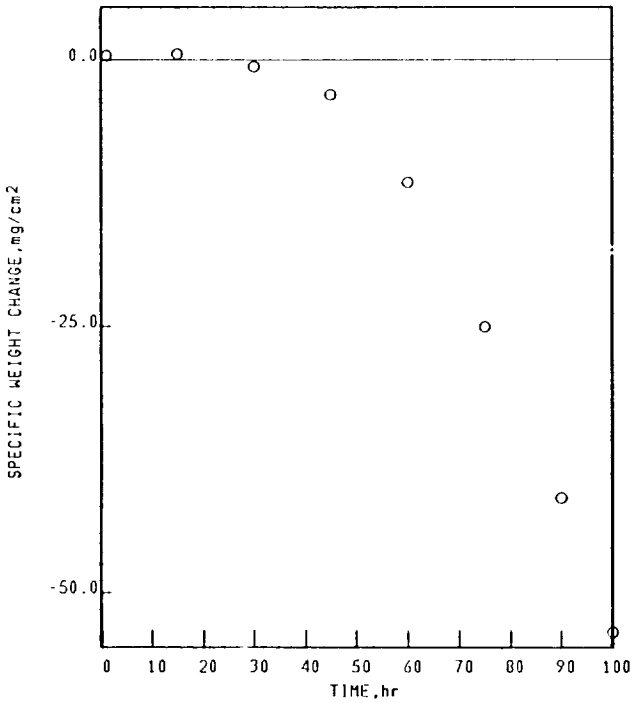
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.30A.

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-101-1

TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 1.657mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

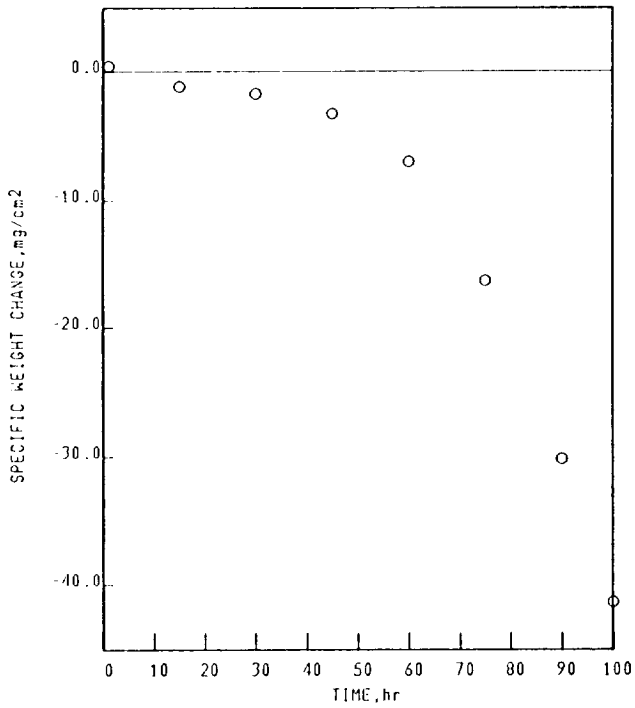


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.40
15.00	0.58
30.00	-0.60
45.00	-3.25
60.00	-11.55
75.00	-25.05
90.00	-41.11
100.00	-53.65

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-101-2

TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 1.680mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.41
15.00	-1.15
30.00	-1.69
45.00	-3.21
60.00	-6.97
75.00	-16.33
90.00	-30.15
100.00	-41.34

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-101-2

TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 1.680mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3
SPINEL, a_0=8.10A.

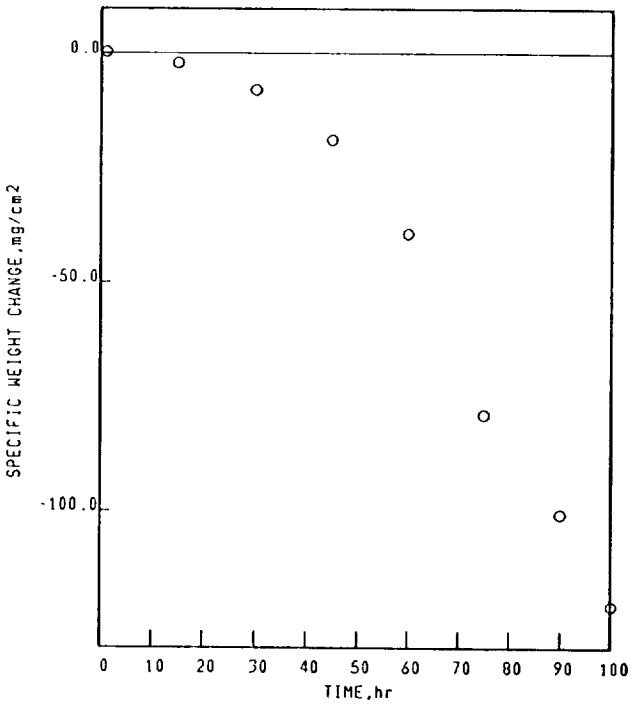
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)≤3.30A.

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-107-3

TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.433mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

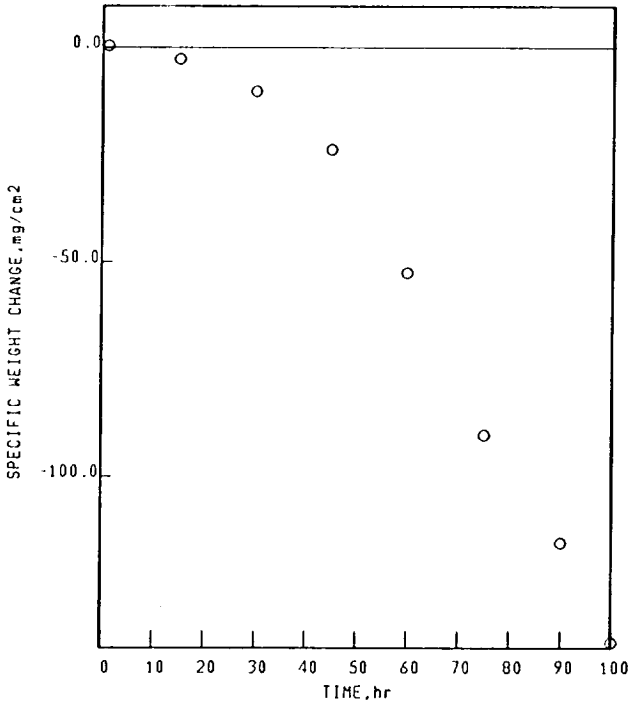


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.23
15.00	-2.17
30.00	-8.10
45.00	-19.04
60.00	-39.37
75.00	-79.07
90.00	-100.63
100.00	-120.87

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-107-6

TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.415mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.36
15.00	-2.73
30.00	-10.30
45.00	-23.84
60.00	-52.53
75.00	-90.48
90.00	-115.44
100.00	-138.95

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-107-6

TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.415mm THICK STATIC AIR

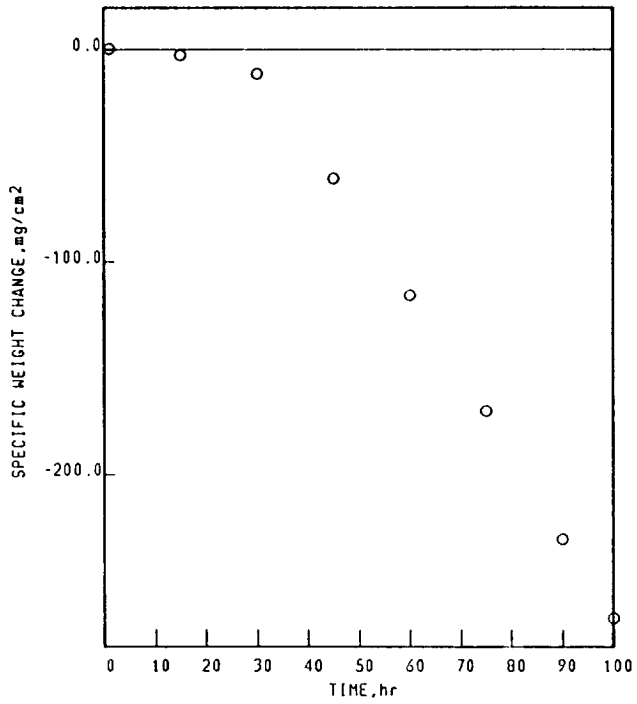
X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
NiO	NiO
TRI(RUTILE),d(110)≤3.30A.	TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.25A.	TRI(RUTILE),d(110)≤3.30A.
FACE CENTERED CUBIC MATRIX	UNKNOWN LINES, d VALUES 2.88A.

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-204-6

TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.427mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.22
15.00	-2.59
30.00	-11.50
45.00	-60.93
60.00	-115.32
75.00	-169.79
90.00	-230.20
100.00	-266.94

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-204-6

TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.427mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
TRI(RUTILE),d(110)>3.30A.
NiO
SPINEL, a_0=8.25A.

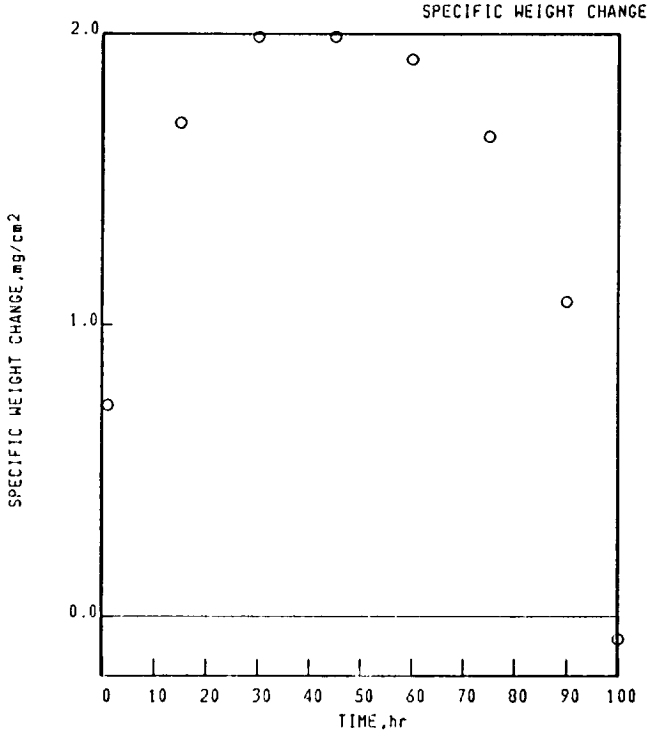
SPALL
100 hr
COLLECTED SPALL
NiO
NiO
TRI(RUTILE),d(110)>3.30A.
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3

UNKNOWN LINES, d VALUES
4.63A.
1.17A.
1.12A.
1.06A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-321-3

TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.315mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.72
15.00	1.69
30.00	1.99
45.00	1.99
60.00	1.91
75.00	1.65
90.00	1.08
100.00	-0.08

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-321-3

TAZ-8A 1150°C 1.00hr CYCLES 100.00hr TEST 2.315mm THICK STATIC AIR

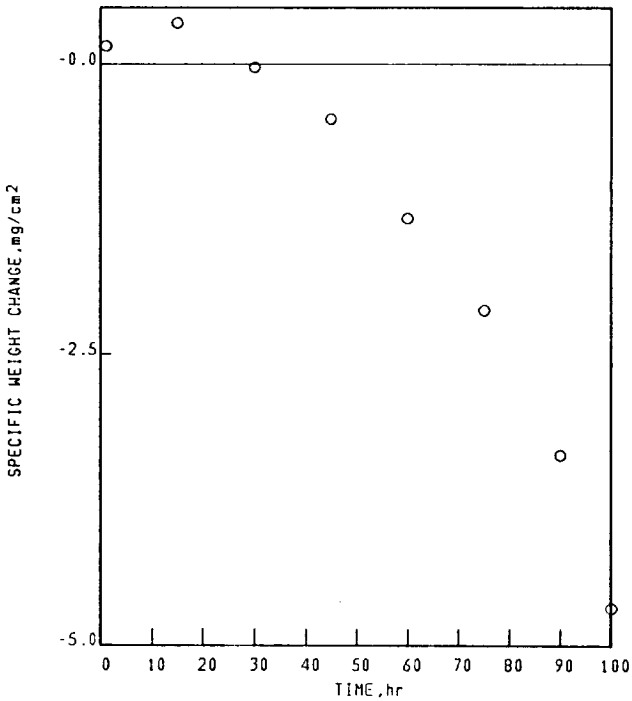
X-RAY DIFFRACTION DATA

SURFACE	SPALL
100 hr	100 hr
STANDARD SURFACE	COLLECTED SPALL
SPINEL, a_0=8.10A.	NiO
TRI(RUTILE),d(110)>3.30A.	TRI(RUTILE),d(110)>3.30A.
NiO	SPINEL, a_0=8.10A.
Al_2O_3	SPINEL, a_0=8.25A.
ZrO_2	$Ni(W,Mo)O_4$ TYPE 1
FACE CENTERED CUBIC MATRIX	UNKNOWN LINES, d VALUES
	2.96A.

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-115-1

TAZ-8A 1100°C 1.00hr CYCLES 100.00hr TEST 2.434mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.16
15.00	0.36
30.00	-0.03
45.00	-0.48
60.00	-1.32
75.00	-2.12
90.00	-3.37
100.00	-4.68

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-115-1

TAZ-8A 1100°C 1.00hr CYCLES 100.00hr TEST 2.434mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3
NiO
SPINEL, a_0=8.25A.

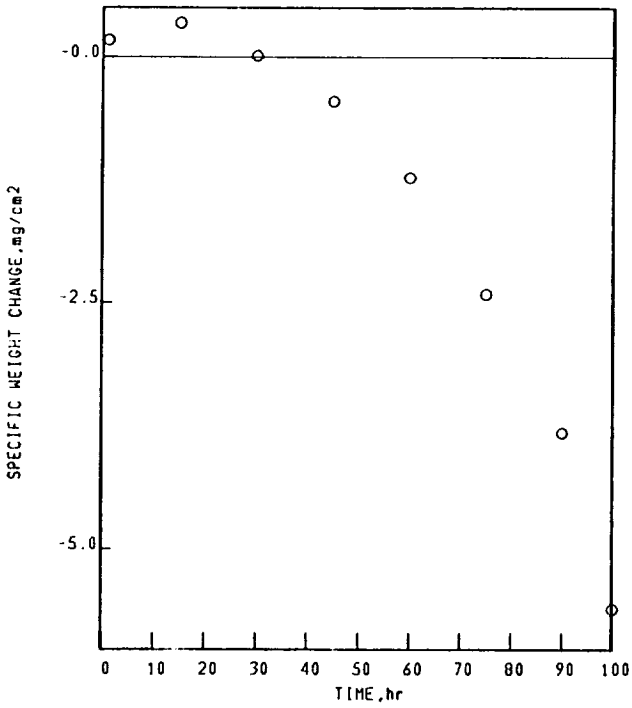
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.10A.
Al_2O_3
SPINEL, a_0=8.25A.

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-115-2

TAZ-8A 1100°C 1.00hr CYCLES 100.00hr TEST 2.434mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

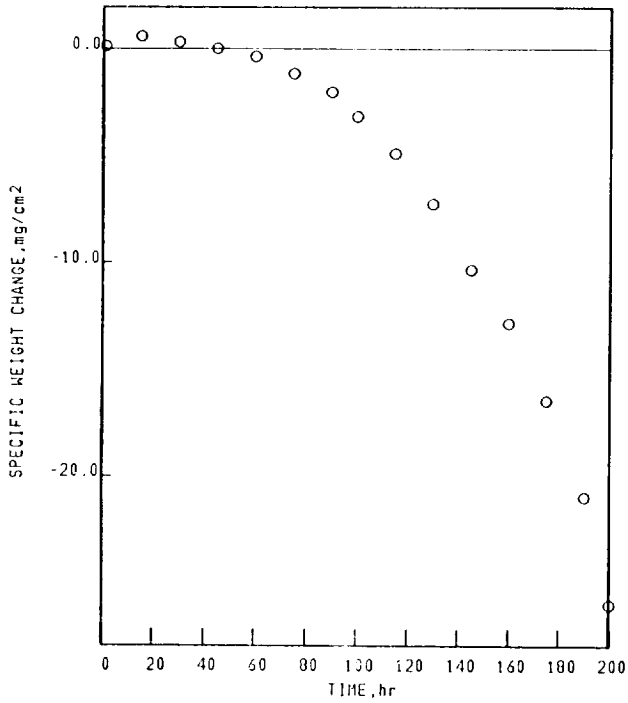


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.17
15.00	0.34
30.00	0.01
45.00	-0.45
60.00	-1.23
75.00	-2.42
90.00	-3.81
100.00	-5.59

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-190-1

TAZ-8A 1100°C 1.00hr CYCLES 200.00hr TEST 2.831mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.12
15.00	0.59
30.00	0.33
45.00	0.01
60.00	-0.36
75.00	-1.15
90.00	-2.03
100.00	-3.16
115.00	-4.87
130.00	-7.22
145.00	-10.34
160.00	-12.88
175.00	-16.51
190.00	-20.97
200.00	-26.08

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-019-190-1

TAZ-8A 1100°C 1.00hr CYCLES 200.00hr TEST 2.831mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.15A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

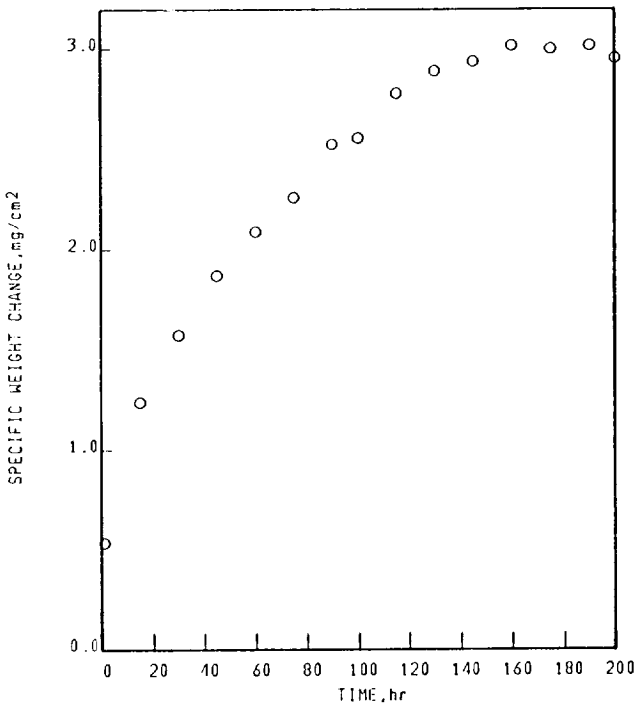
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
PROBABLE CROSS-SPALL
Fe_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-324-3

TAZ-8A 1100°C 1.00hr CYCLES 200.00hr TEST 2.315mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.53
15.00	1.24
30.00	1.57
45.00	1.87
60.00	2.09
75.00	2.26
90.00	2.53
100.00	2.56
115.00	2.78
130.00	2.89
145.00	2.94
160.00	3.01
175.00	3.00
190.00	3.01
200.00	2.95

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-019-324-3

TAZ-8A 1100°C 1.00hr CYCLES 200.00hr TEST 2.315mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
TRI(RUTILE),d(110)>3.30A.
NiO
$Ni(W,Mo)O_4$ TYPE 1
Al_2O_3

FACE CENTERED CUBIC MATRIX

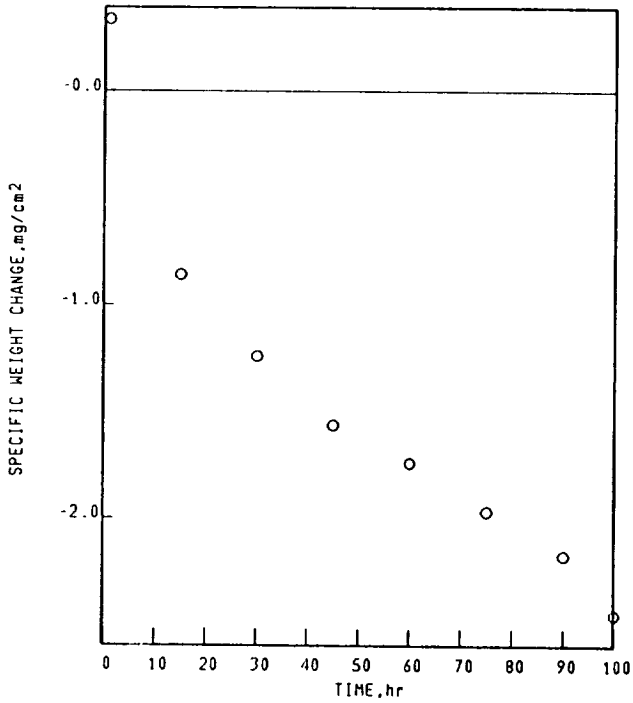
SPALL
200 hr
COLLECTED SPALL
NiO
$Ni(W,Mo)O_4$ TYPE 1
SPINEL, a_0=8.25A.
SPINEL, a_0=8.05A.
TRI(RUTILE),d(110)>3.30A.
Al_2O_3
$Ni(W,Mo)O_4$ TYPE 2

3.57A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-032-322-2

TRW-R 1150°C 1.00hr CYCLES 100.00hr TEST 2.338mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.34
15.00	-0.86
30.00	-1.24
45.00	-1.57
60.00	-1.75
75.00	-1.97
90.00	-2.17
100.00	-2.46

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-032-322-2

TRW-R 1150°C 1.00hr CYCLES 100.00hr TEST 2.338mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.
HfO_2

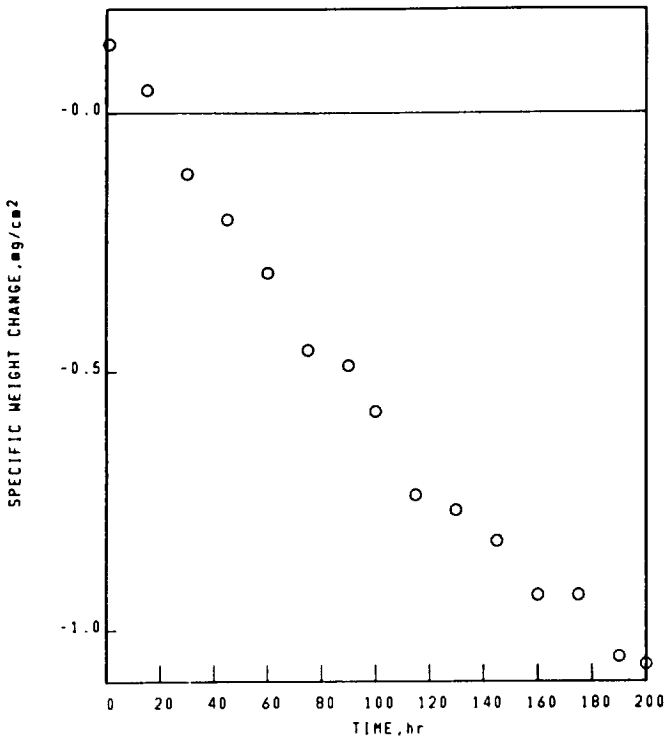
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
TRI(RUTILE),d(110)≤3.30A.
SPINEL, a_0=8.10A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-032-325-2

TRW-R 1100°C 1.00hr CYCLES 200.00hr TEST 2.335mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.13
15.00	0.04
30.00	-0.12
45.00	-0.21
60.00	-0.31
75.00	-0.46
90.00	-0.49
100.00	-0.58
115.00	-0.74
130.00	-0.77
145.00	-0.83
160.00	-0.93
175.00	-0.93
190.00	-1.05
200.00	-1.07

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-032-325-2

TRW-R 1100°C 1.00hr CYCLES 200.00hr TEST 2.335mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE), d(110)≤3.30A.
HfO_2

FACE CENTERED CUBIC MATRIX

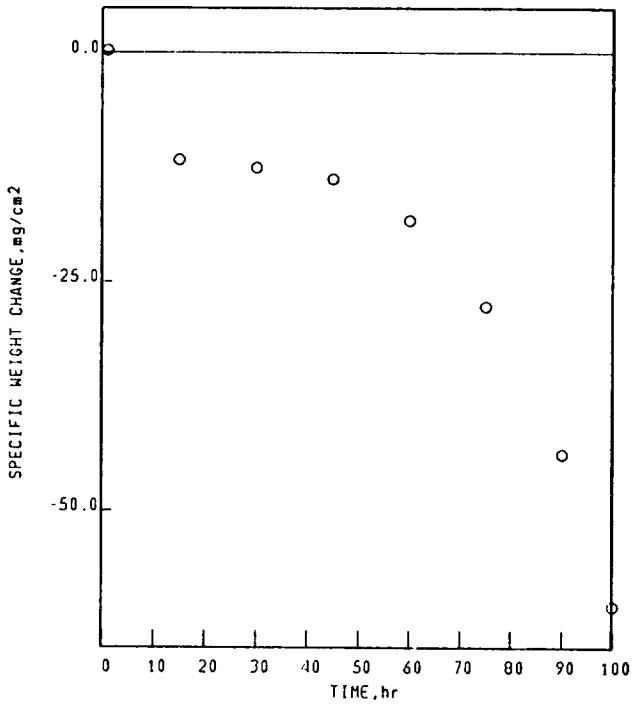
SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
TRI(RUTILE), d(110)≤3.30A.
SPINEL, a_0=8.05A.
Cr_2O_3
Al_2O_3

UNKNOWN LINES, d VALUES
2.70A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-022-321-6

UDIMET-700 1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.23
15.00	-11.64
30.00	-12.50
45.00	-13.72
60.00	-18.25
75.00	-27.74
90.00	-43.79
100.00	-60.56

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-022-321-6

UDIMET-700 1150°C 1.00hr CYCLES 100.00hr TEST 2.310mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.25A.
SPINEL, a_0=8.10A.
$NiTiO_3$
Cr_2O_3
Al_2O_3
TRI(RUTILE),d(110)≤3.30A.

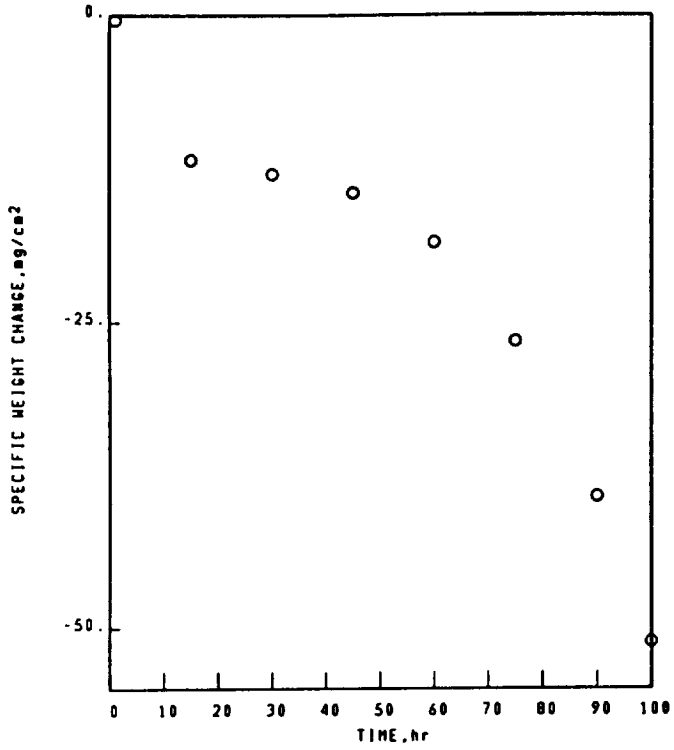
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.
$Ni(W,Mo)O_4$ TYPE 2
Cr_2O_3

Ni BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-016-323-6

U-700 1150°C 1.00hr CYCLES 100.00hr TEST 1.760mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	-0.38
15.00	-11.84
30.00	-13.08
45.00	-14.53
60.00	-18.51
75.00	-26.57
90.00	-39.37
100.00	-51.14

Ni BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-016-323-6

U-700 1150°C 1.00hr CYCLES 100.00hr TEST 1.760mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.30A.
SPINEL, a_0=8.10A.
NiO
Cr_2O_3
$(Ni,Co,Fe)TiO_3$
Al_2O_3
TRI(RUTILE), d(110)≤3.30A.

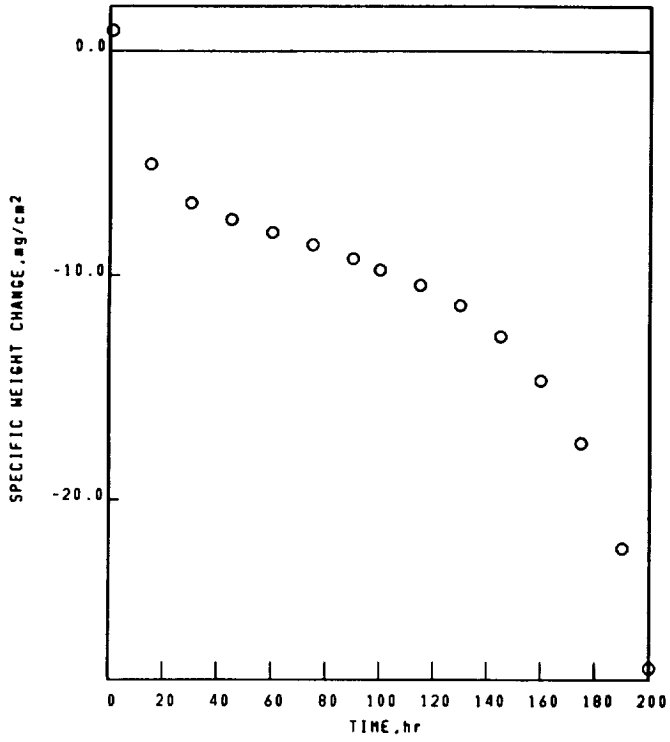
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-022-251-1

U-700 1100°C 1.00hr CYCLES 200.00hr TEST 1.752mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.91
15.00	-5.01
30.00	-6.74
45.00	-7.48
60.00	-8.07
75.00	-8.63
90.00	-9.24
100.00	-9.75
115.00	-10.43
130.00	-11.34
145.00	-12.73
160.00	-14.66
175.00	-17.45
190.00	-22.17
200.00	-27.48

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-022-251-1

U-700 1100°C 1.00hr CYCLES 200.00hr TEST 1.752mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.15A.
TRI(RUTILE), d(110)≤3.30A.
Al_2O_3
TRI(RUTILE), d(110)≤3.30A.

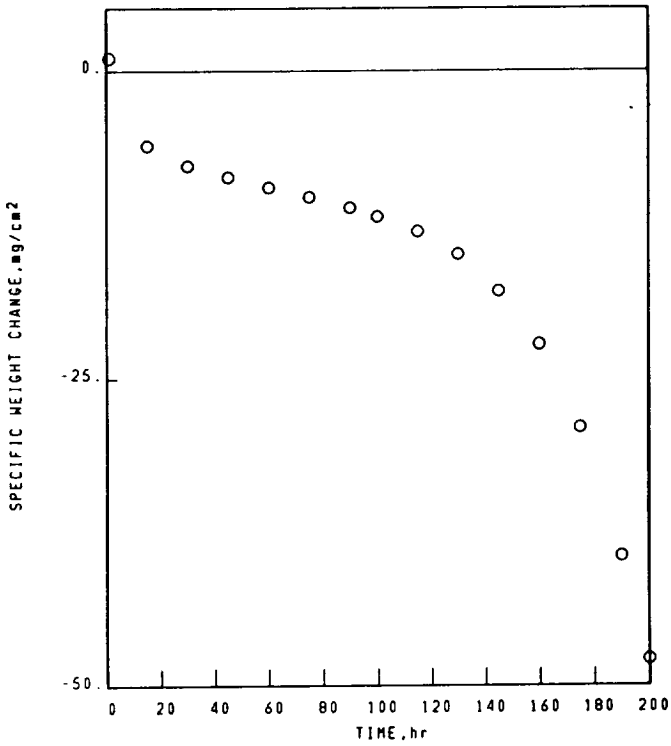
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.
Cr_2O_3
TRI(RUTILE), d(110)≤3.30A.
$Ni(W,Mo)O_4$ TYPE 1

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-022-251-2

U-700 1100°C 1.00hr CYCLES 200.00hr TEST 1.756mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	1.02
15.00	-6.06
30.00	-7.68
45.00	-8.62
60.00	-9.48
75.00	-10.25
90.00	-11.13
100.00	-11.87
115.00	-13.10
130.00	-14.97
145.00	-17.99
160.00	-22.29
175.00	-29.02
190.00	-39.52
200.00	-47.83

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-022-251-2

U-700 1100°C 1.00hr CYCLES 200.00hr TEST 1.756mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.15A.
TRI(RUTILE), d(110)≤3.30A.
Al_2O_3
TRI(RUTILE), d(110)≤3.30A.
Cr_2O_3

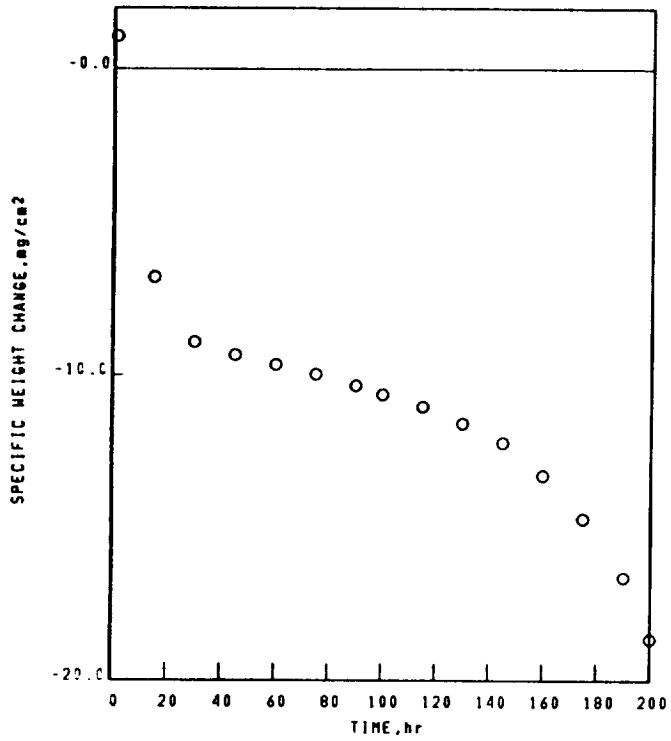
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.
TRI(RUTILE), d(110)≤3.30A.
Cr_2O_3
$Ni(W,Mo)O_4$ TYPE 1

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-022-266-1

U-700 1100°C 1.00hr CYCLES 200.00hr TEST 1.729mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

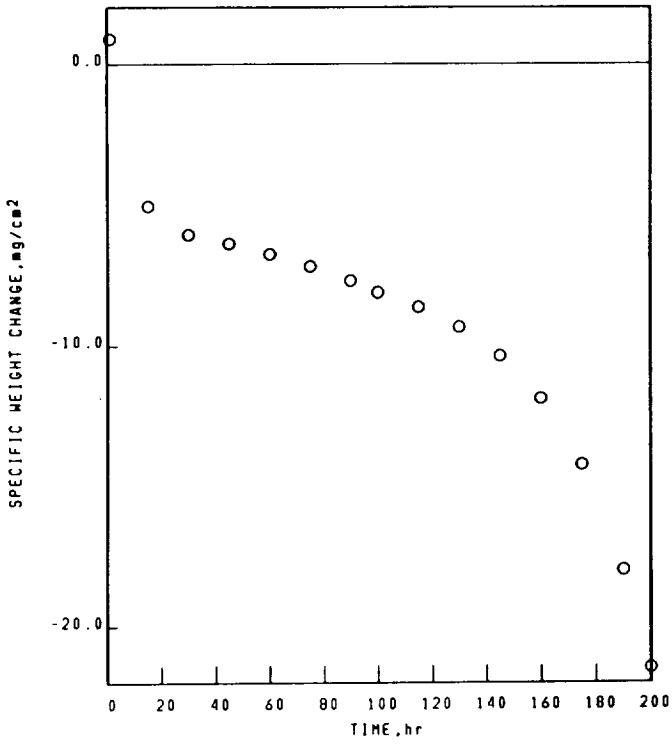


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	1.07
15.00	-6.76
30.00	-8.91
45.00	-9.33
60.00	-9.65
75.00	-9.96
90.00	-10.34
100.00	-10.63
115.00	-11.03
130.00	-11.58
145.00	-12.20
160.00	-13.24
175.00	-14.66
190.00	-16.61
200.00	-18.64

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-04-022-269-1

U-700 1100°C 1.00hr CYCLES 200.00hr TEST 1.732mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

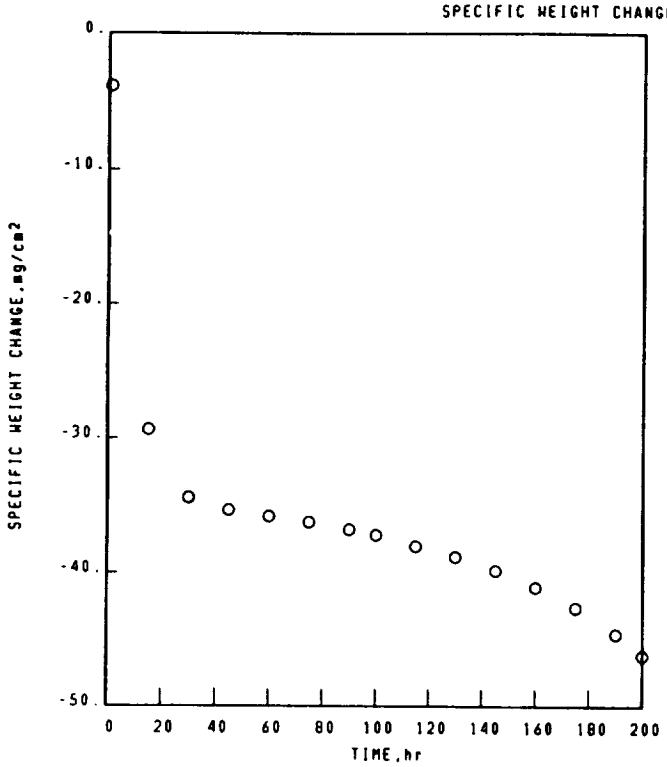


TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.89
15.00	-5.06
30.00	-6.07
45.00	-6.39
60.00	-6.78
75.00	-7.20
90.00	-7.71
100.00	-8.11
115.00	-8.62
130.00	-9.33
145.00	-10.37
160.00	-11.89
175.00	-14.28
190.00	-18.03
200.00	-21.46

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-016-310-6

U-700 1100°C 1.00hr CYCLES 200.00hr TEST 1.762mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	-3.89
15.00	-29.37
30.00	-34.39
45.00	-35.31
60.00	-35.78
75.00	-36.23
90.00	-36.76
100.00	-37.17
115.00	-38.00
130.00	-38.79
145.00	-39.83
160.00	-41.06
175.00	-42.65
190.00	-44.59
200.00	-46.18

Ni BASE EXPERIMENTAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-016-310-6

U-700 1100°C 1.00hr CYCLES 200.00hr TEST 1.762mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
Al_2O_3
TRI(RUTILE), d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

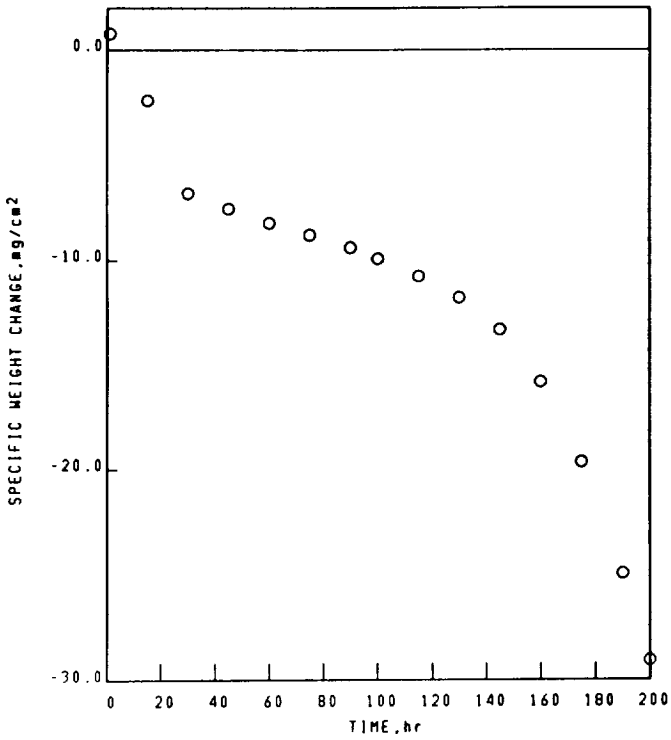
SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.

UNKNOWN LINES, d VALUES
3.09A.
2.44A.

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-022-324-6

U-700 1100°C 1.00hr CYCLES 200.00hr TEST 2.308mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.77
15.00	-2.42
30.00	-6.86
45.00	-7.61
60.00	-8.28
75.00	-8.84
90.00	-9.42
100.00	-9.95
115.00	-10.77
130.00	-11.79
145.00	-13.32
160.00	-15.83
175.00	-19.67
190.00	-24.92
200.00	-29.06

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-022-324-6

U-700 1100°C 1.00hr CYCLES 200.00hr TEST 2.308mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.10A.
NiO
SPINEL, a_0=8.25A.
$(Ni,Co,Fe)TiO_3$
Cr_2O_3
TRI(RUTILE), d(110)≤3.30A.

FACE CENTERED CUBIC MATRIX

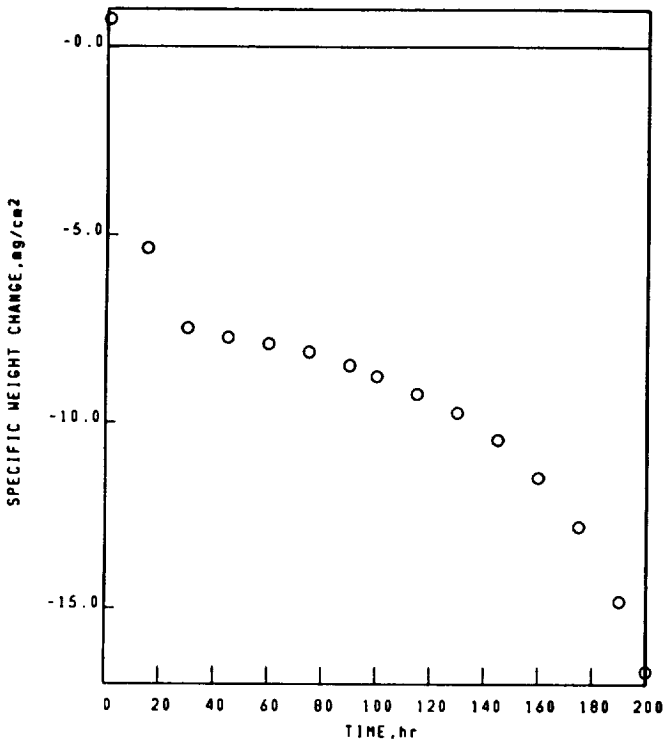
SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
$(Ni,Co,Fe)TiO_3$
Al_2O_3

UNKNOWN LINES, d VALUES
3.10A.

Ni BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-016-326-6

U-700 1100°C 1.00hr CYCLES 200.00hr TEST 1.748mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	0.73
15.00	-5.35
30.00	-7.50
45.00	-7.75
60.00	-7.92
75.00	-8.14
90.00	-8.48
100.00	-8.76
115.00	-9.24
130.00	-9.73
145.00	-10.45
160.00	-11.47
175.00	-12.80
190.00	-14.80
200.00	-16.65

Ni BASE COMMERCIAL HOT WORKED GAMMA/GAMMA PRIME ALLOYS 02-13-016-326-6

U-700 1100°C 1.00hr CYCLES 200.00hr TEST 1.748mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.15A.
SPINEL, a_0=8.30A.
$(Ni,Co,Fe)TiO_3$
Cr_2O_3
TRI(RUTILE),d(110)≤3.30A.
Al_2O_3

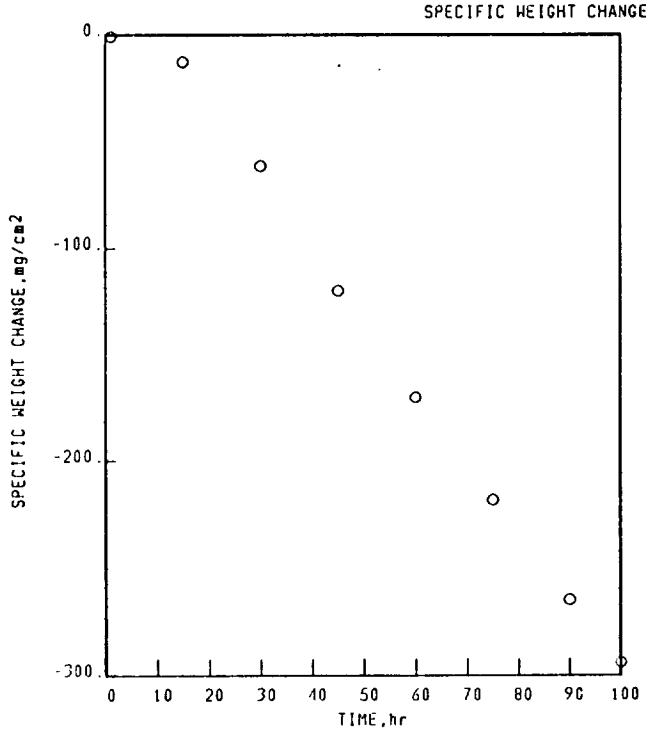
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
SPINEL, a_0=8.30A.
NiO
$Ni(W,Mo)O_4$ TYPE 1
TRI(RUTILE),d(110)≤3.30A.
$(Ni,Co,Fe)TiO_3$
Cr_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-023-321-5

UDIMET-710 1150°C 1.00hr CYCLES 100.00hr TEST 2.329mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	-0.99
15.00	-12.97
30.00	-61.94
45.00	-120.03
60.00	-170.19
75.00	-218.44
90.00	-264.68
100.00	-294.07

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-023-321-5

UDIMET-710 1150°C 1.00hr CYCLES 100.00hr TEST 2.329mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.30A.
NiO
Cr_2O_3
$NiTiO_3$
TRI(RUTILE), d(110)≤3.30A.

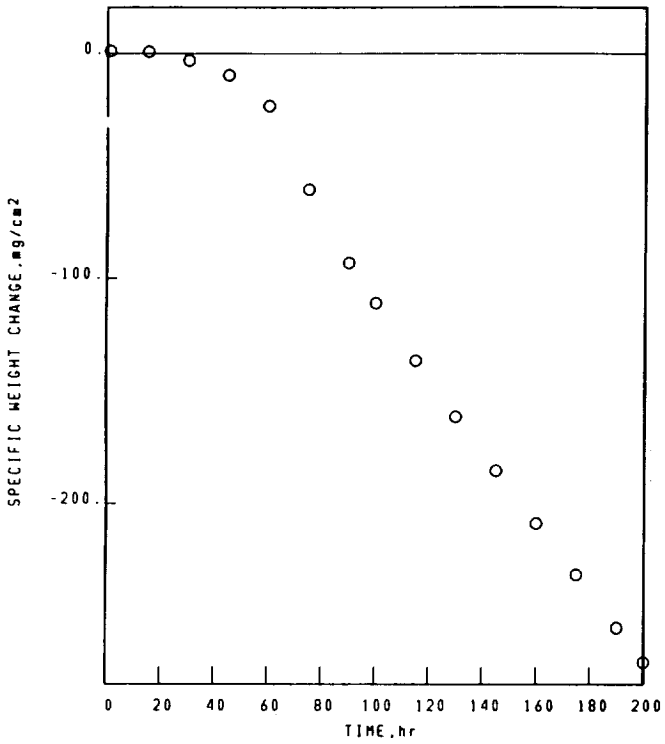
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.25A.
$Ni(W,Mo)O_4$ TYPE 2
Cr_2O_3

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-023-324-S

UDIMET-710 1100°C 1.00hr CYCLES 200.00hr TEST 2.319mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	1.04
15.00	0.69
30.00	-3.13
45.00	-9.66
60.00	-23.09
75.00	-60.49
90.00	-93.21
100.00	-111.14
115.00	-136.29
130.00	-161.11
145.00	-185.11
160.00	-208.69
175.00	-231.76
190.00	-255.12
200.00	-270.20

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-023-324-S

UDIMET-710 1100°C 1.00hr CYCLES 200.00hr TEST 2.319mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.30A.
NiO
Cr_2O_3
$Ni(W,Mo)O_4$ TYPE 2
TRI(RUTILE), d(110)≤3.30A.

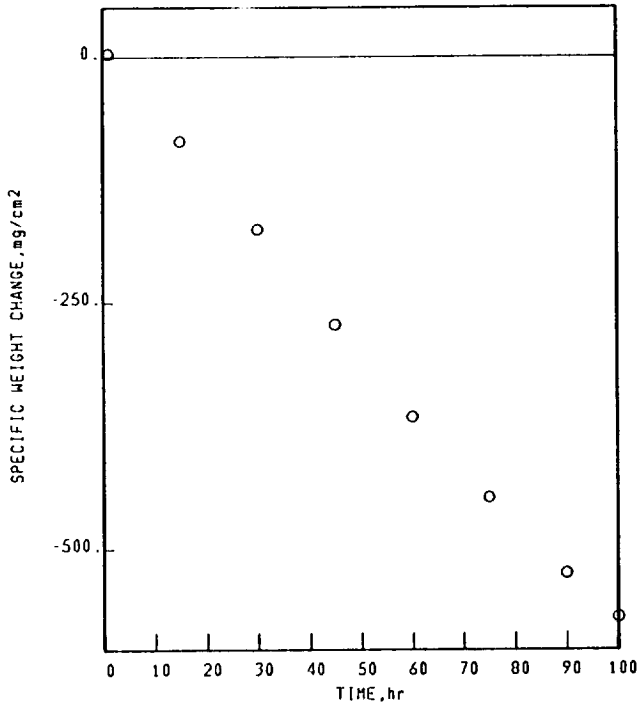
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
NiO
SPINEL, a_0=8.30A.
Cr_2O_3
$(Ni,Co,Fe)TiO_3$

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-024-102-4

WAZ-20 1150°C 1.00hr CYCLES 100.00hr TEST 2.725mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

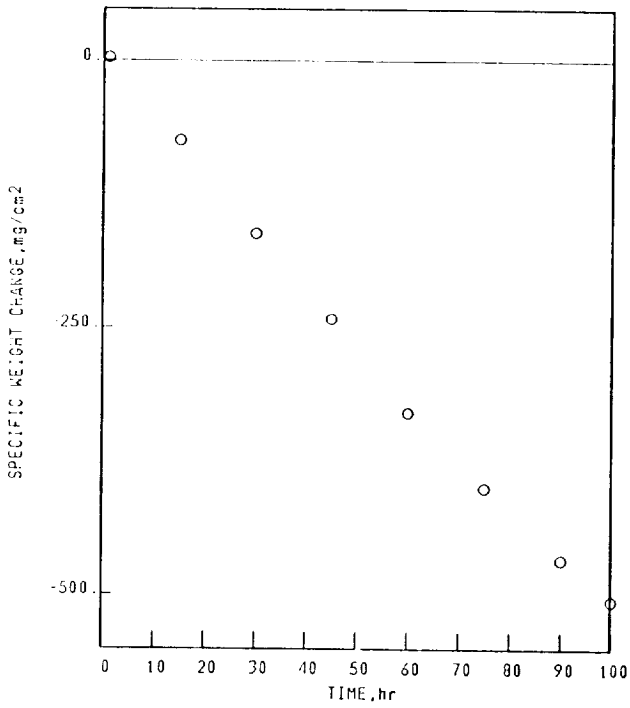


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	3.36
15.00	-85.34
30.00	-175.66
45.00	-272.21
60.00	-364.84
75.00	-447.27
90.00	-524.02
100.00	-568.27

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-024-102-5

WAZ-20 1150°C 1.00hr CYCLES 100.00hr TEST 2.705mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	2.76
15.00	-74.59
30.00	-160.94
45.00	-241.34
60.00	-329.45
75.00	-398.74
90.00	-465.65
100.00	-505.33

Ni BASE COMMERCIAL CAST GAMMA/GAMMA PRIME ALLOYS 02-04-024-102-5

WAZ-20 1150°C 1.00hr CYCLES 100.00hr TEST 2.705mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
$Ni(W,Mo)O_4$ TYPE 1

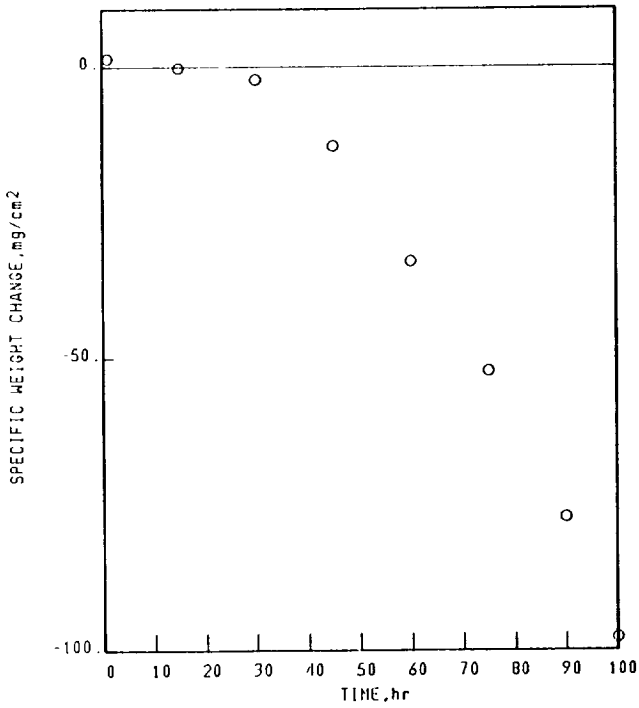
SPALL
100 hr
COLLECTED SPALL
$Ni(W,Mo)O_4$ TYPE 1
Cr_2O_3

UNKNOWN LINES, d VALUES
3.80A.
1.54A.
1.00A.
1.36A.

Co BASE CAST (TURBINE) ALLOYS 03-02-003-102-1

MAR-M-509 1150°C 1.00hr CYCLES 100.00hr TEST 2.515mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

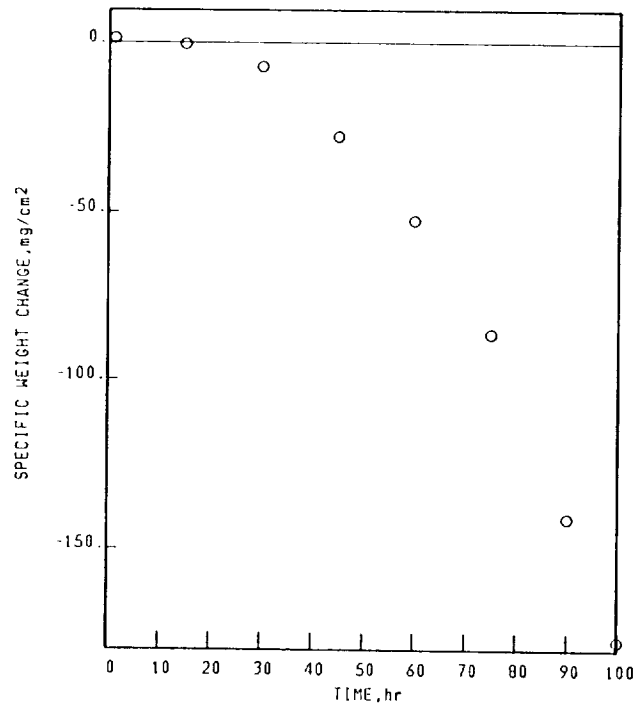


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	1.45
15.00	-0.16
30.00	-2.13
45.00	-13.60
60.00	-33.61
75.00	-52.28
90.00	-77.50
100.00	-97.87

Co BASE CAST (TURBINE) ALLOYS 03-02-003-102-2

MAR-M-509 1150°C 1.00hr CYCLES 100.00hr TEST 2.523mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	1.27
15.00	-0.40
30.00	-7.22
45.00	-27.82
60.00	-52.49
75.00	-86.38
90.00	-140.68
100.00	-177.51

Co BASE CAST (TURBINE) ALLOYS 03-02-003-102-2

MAR-M-509 1150°C 1.00hr CYCLES 100.00hr TEST 2.523mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

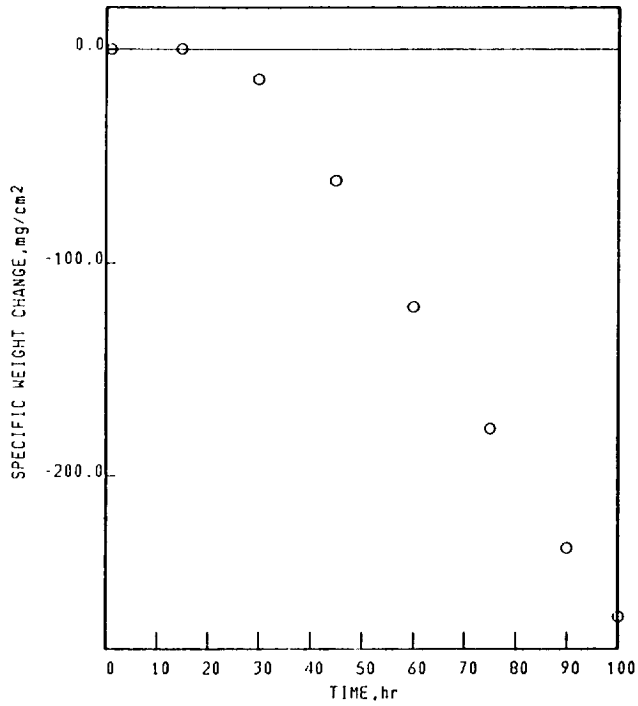
SURFACE
100 hr
STANDARD SURFACE
Cr_2O_3
SPINEL, a_0=8.35A.

SPALL
100 hr
COLLECTED SPALL
CoO
SPINEL, a_0=8.25A.
Cr_2O_3

Co BASE CAST (TURBINE) ALLOYS 03-02-003-323-4

MAR-M-509 1150°C 1.00hr CYCLES 100.00hr TEST 2.338mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	-0.10
15.00	0.10
30.00	-14.11
45.00	-61.87
60.00	-120.62
75.00	-177.90
90.00	-233.02
100.00	-265.19

Co BASE CAST (TURBINE) ALLOYS 03-02-003-323-4

MAR-M-509 1150°C 1.00hr CYCLES 100.00hr TEST 2.338mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.30A.
CoO
Cr_2O_3

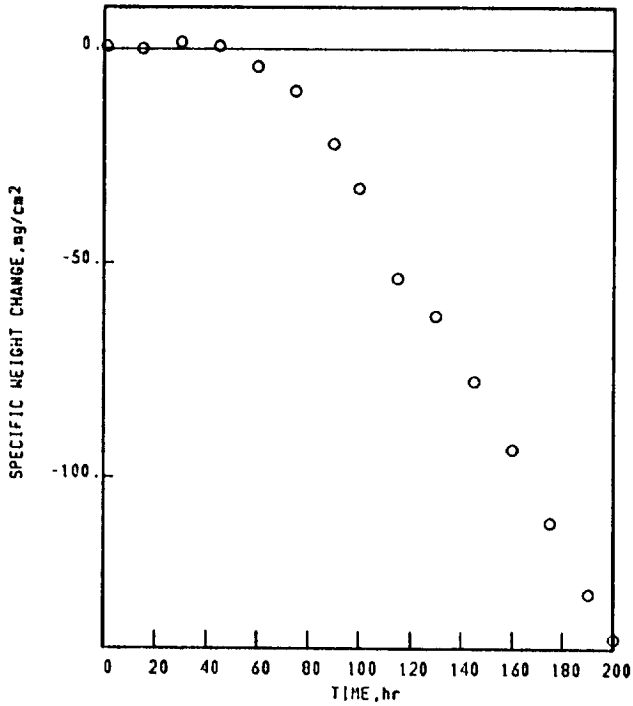
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
CoO
SPINEL, a_0=8.30A.
$Ni(W,Mo)O_4$ TYPE 1

Co BASE CAST (TURBINE) ALLOYS 03-02-003-310-1

MAR-M-509 1100°C 1.00hr CYCLES 200.00hr TEST 2.330mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.62
15.00	0.06
30.00	1.61
45.00	0.68
60.00	-4.03
75.00	-9.61
90.00	-21.89
100.00	-32.34
115.00	-53.60
130.00	-62.38
145.00	-77.45
160.00	-93.43
175.00	-110.65
190.00	-127.44
200.00	-137.90

Co BASE CAST (TURBINE) ALLOYS 03-02-003-310-1

MAR-M-509 1100°C 1.00hr CYCLES 200.00hr TEST 2.330mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

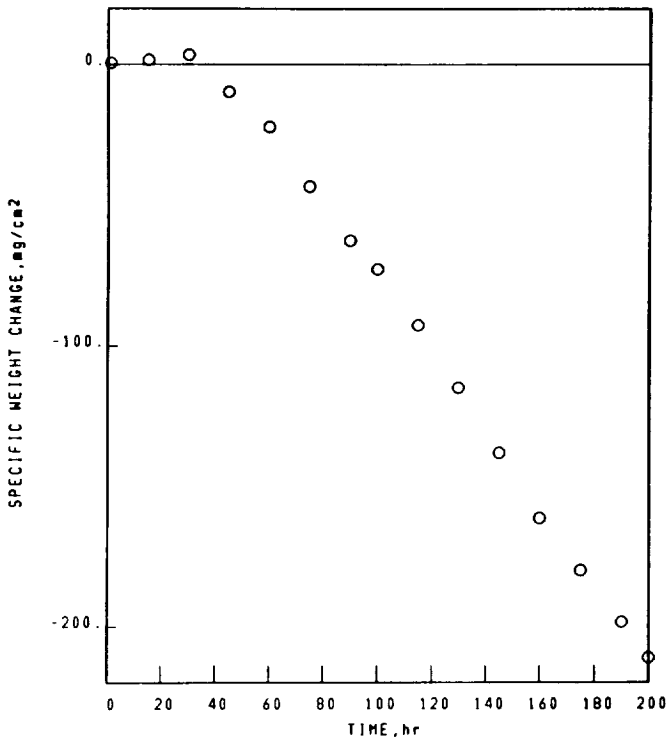
SURFACE
200 hr
STANDARD SURFACE
SPINEL, a_0=8.35A.
CoO

SPALL
200 hr
COLLECTED SPALL
SPINEL, a_0=8.35A.
CoO
Al_2TiO_5

Co BASE CAST (TURBINE) ALLOYS 03-02-003-326-4

MAR-M-509 1100°C 1.00hr CYCLES 200.00hr TEST 2.327mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.56
15.00	1.64
30.00	3.52
45.00	-9.71
60.00	-22.28
75.00	-43.42
90.00	-62.52
100.00	-72.71
115.00	-92.81
130.00	-115.17
145.00	-138.43
160.00	-161.24
175.00	-179.81
190.00	-198.26
200.00	-211.15

Co BASE CAST (TURBINE) ALLOYS 03-02-003-326-4

MAR-M-509 1100°C 1.00hr CYCLES 200.00hr TEST 2.327mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
200 hr
STANDARD SURFACE
CoO
SPINEL, a_0=8.35A.
Al_2TiO_5

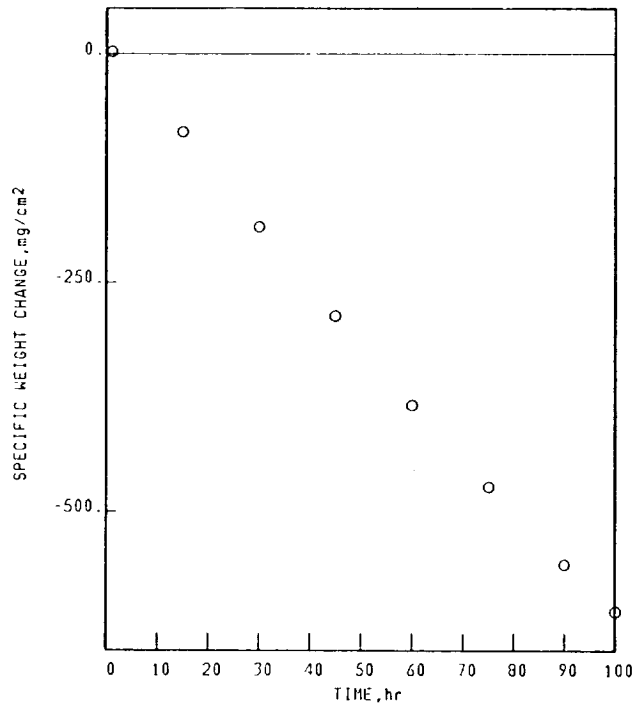
FACE CENTERED CUBIC MATRIX

SPALL
200 hr
COLLECTED SPALL
SPINEL, a_0=8.35A.
CoO
Al_2TiO_5

Co BASE CAST (TURBINE) ALLOYS 03-02-002-099-1

WI-52 1150°C 1.00hr CYCLES 100.00hr TEST 2.720mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

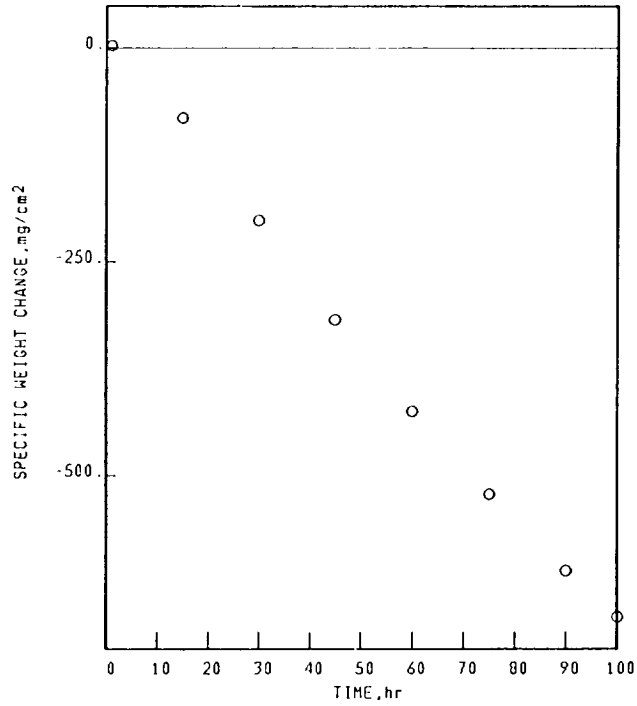


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	2.49
15.00	-85.39
30.00	-189.58
45.00	-286.05
60.00	-383.38
75.00	-472.69
90.00	-557.34
100.00	-608.21

Co BASE CAST (TURBINE) ALLOYS 03-02-002-099-2

WI-52 1150°C 1.00hr CYCLES 100.00hr TEST 2.694mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	2.65
15.00	-81.87
30.00	-202.28
45.00	-317.06
60.00	-424.07
75.00	-521.30
90.00	-609.22
100.00	-663.28

Co BASE CAST (TURBINE) ALLOYS 03-02-002-099-2

WI-52 1150°C 1.00hr CYCLES 100.00hr TEST 2.694mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.35A.
Cr_2O_3
$CoWO_4$ 15-867

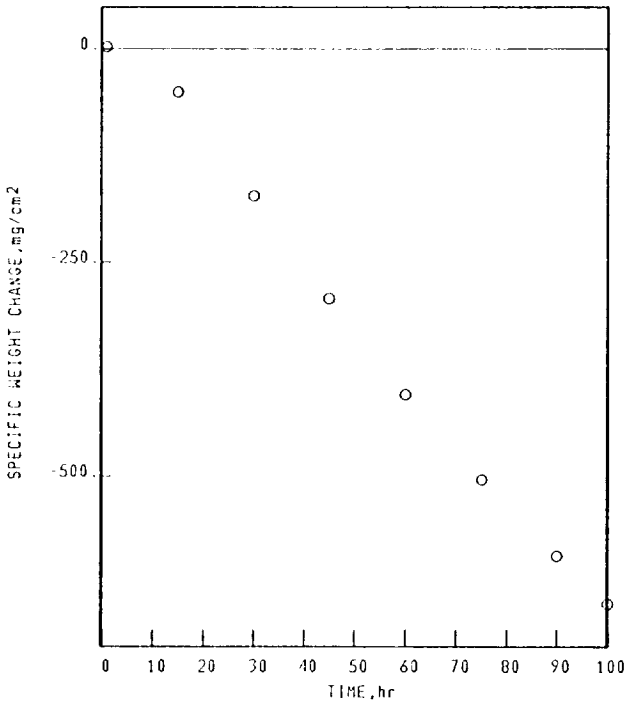
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
CoO
SPINEL, a_0=8.35A.
$CoWO_4$ 15-867

Co BASE CAST (TURBINE) ALLOYS 03-02-002-105-4

WI 52 1150°C 1.00hr CYCLES 100.00hr TEST 2.651mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

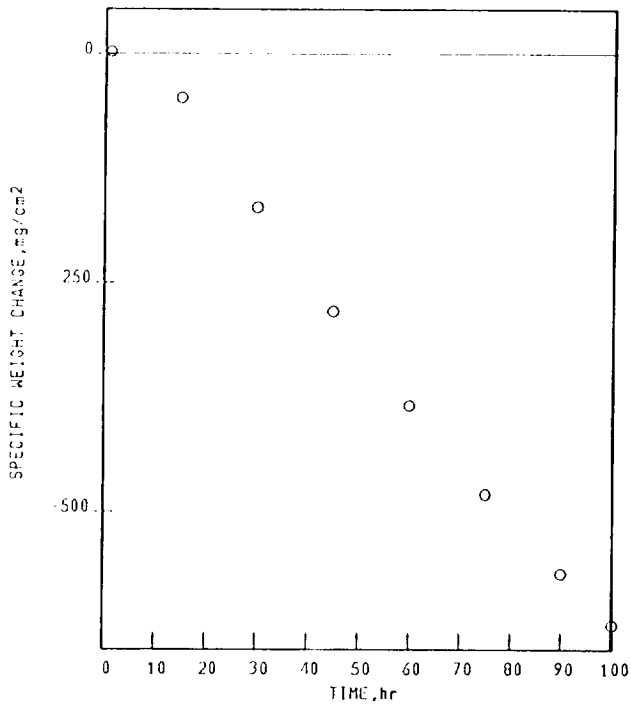


TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	2.25
15.00	-49.38
30.00	-171.39
45.00	-292.62
60.00	-403.98
75.00	-503.75
90.00	-594.00
100.00	-650.60

Co BASE CAST (TURBINE) ALLOYS 03-02-002-105-S

WI-52 1150°C 1.00hr CYCLES 100.00hr TEST 2.657mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm^2
0.00	0.00
1.00	2.28
15.00	-48.40
30.00	-167.99
45.00	-281.23
60.00	-385.22
75.00	-481.24
90.00	-567.32
100.00	-623.71

Co BASE CAST (TURBINE) ALLOYS 03-02-002-105-S

WI-52 1150°C 1.00hr CYCLES 100.00hr TEST 2.657mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

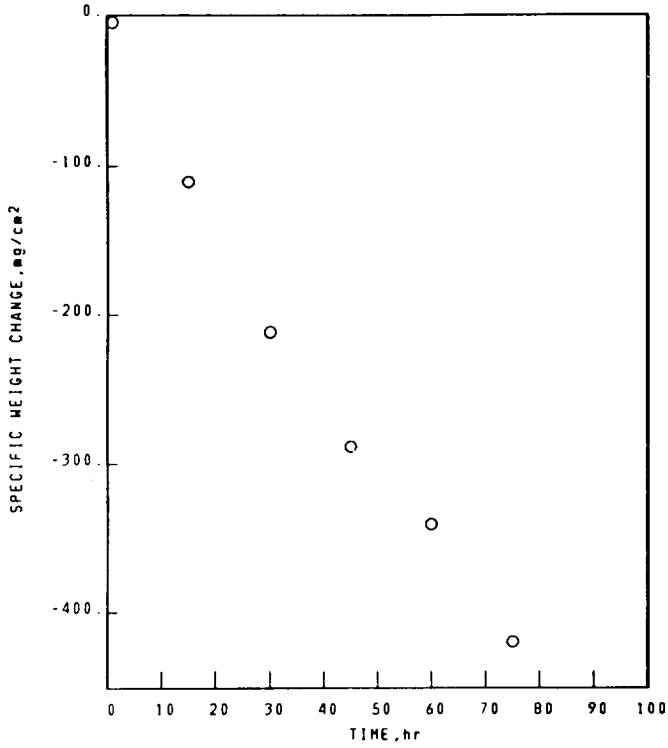
SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.35A.
Cr_2O_3
NiO

SPALL
100 hr
COLLECTED SPALL
CoO
SPINEL, a_0=8.20A.
SPINEL, a_0=8.30A.
Al_2O_3

Co BASE CAST (TURBINE) ALLOYS 03-02-002-128-5

WI-52 1150°C 1.00hr CYCLES 75.00hr TEST 3.226mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

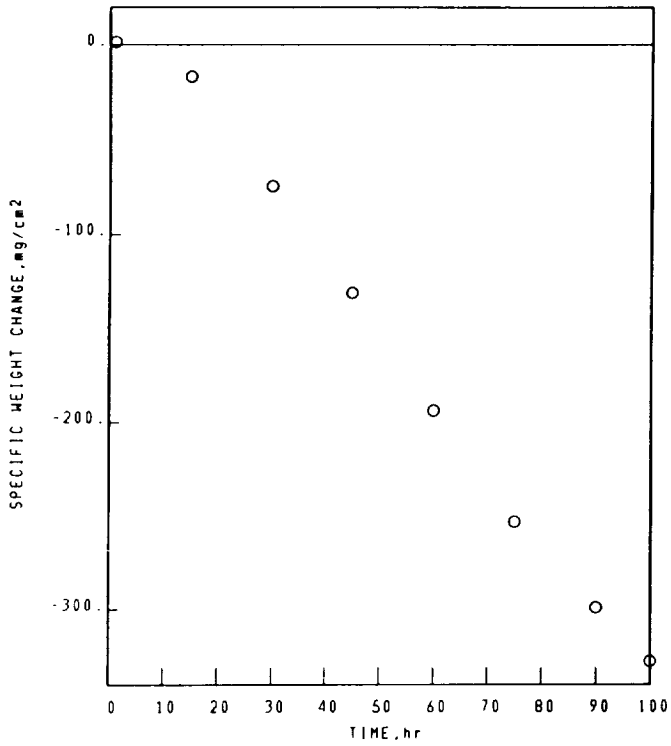


TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	-4.82
15.00	-110.82
30.00	-211.43
45.00	-288.20
60.00	-340.42
75.00	-418.96

Co BASE CAST (TURBINE) ALLOYS 03-02-002-120-1

W.-52 1093°C 1.00hr CYCLES 100.00hr TEST 3.226mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

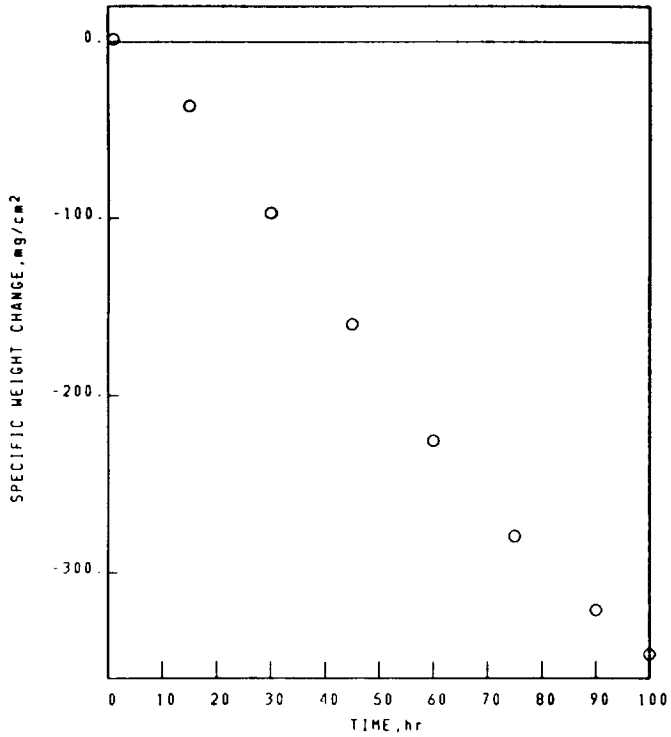


TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	1.45
15.00	-16.88
30.00	-74.28
45.00	-131.47
60.00	-194.07
75.00	-253.06
90.00	-298.92
100.00	-327.52

Co BASE CAST (TURBINE) ALLOYS 03-02-002-120-2

WI-52 1093°C 1.00hr CYCLES 100.00hr TEST 3.226mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	1.42
15.00	-36.47
30.00	-97.13
45.00	-159.57
60.00	-225.73
75.00	-279.36
90.00	-320.91
100.00	-346.38

Co BASE CAST (TURBINE) ALLOYS 03-02-002-120-2

WI-52 1093°C 1.00hr CYCLES 100.00hr TEST 3.226mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

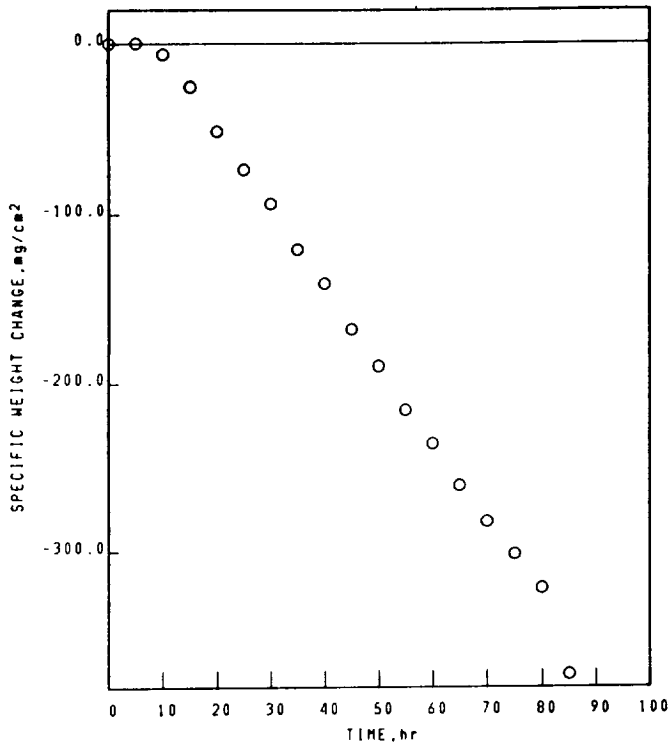
SURFACE
100 hr
STANDARD SURFACE
Cr_2O_3
$CoWO_4$ 15-867
CoO
SPINEL, a_0=8.35A.
TRI(RUTILE), d(110)>3.30A.

SPALL
100 hr
COLLECTED SPALL
CoO
SPINEL, a_0=8.30A.
$CoWO_4$ 15-867

Co BASE CAST (TURBINE) ALLOYS 03-02-002-151-1

WI-52 1093°C 0.05hr CYCLES 85.00hr TEST 3.226mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
0.05	0.07
5.00	0.28
10.00	-6.07
15.00	-24.80
20.00	-51.01
25.00	-73.54
30.00	-93.90
35.00	-121.18
40.00	-141.62
45.00	-168.72
50.00	-190.32
55.00	-216.15
60.00	-235.91
65.00	-260.99
70.00	-282.52
75.00	-301.78
80.00	-321.90
85.00	-372.34

Co BASE CAST (TURBINE) ALLOYS 03-02-002-151-1

WI-52 1093°C 0.05hr CYCLES 85.00hr TEST 3.226mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
CoO
SPINEL, a_0=8.30A.
Cr_2O_3

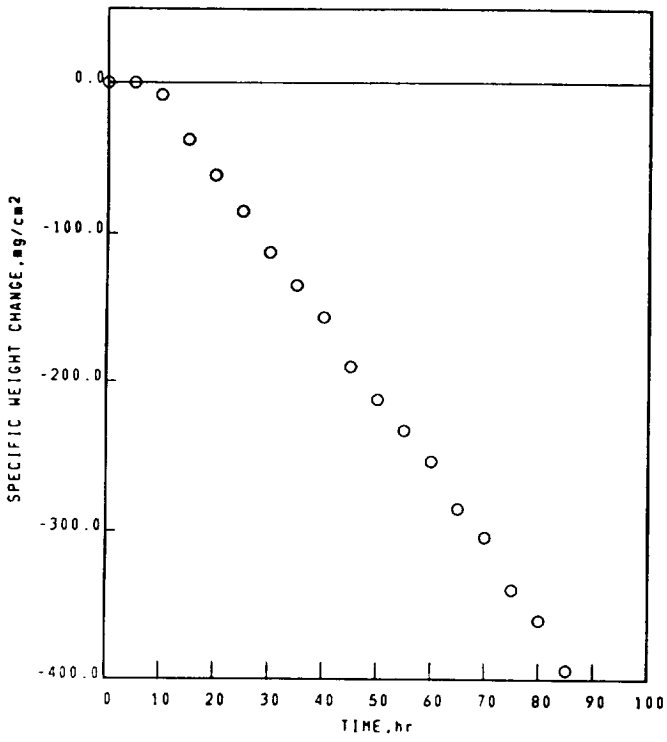
FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
CoO
SPINEL, a_0=8.30A.

Co BASE CAST (TURBINE) ALLOYS 03-02-002-151-2

WI-52 1093°C 0.05hr CYCLES 85.00hr TEST 3.277mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

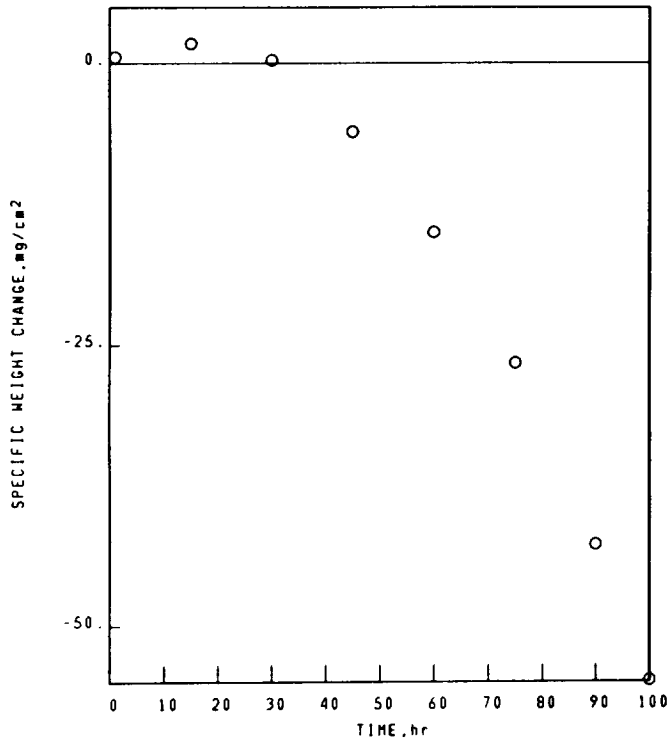


TIME,hr	ΔW/A,mg/cm²
0.00	0.00
0.05	0.07
5.00	0.18
10.00	-8.08
15.00	-37.93
20.00	-61.72
25.00	-85.37
30.00	-112.80
35.00	-134.93
40.00	-156.48
45.00	-190.09
50.00	-212.17
55.00	-232.95
60.00	-253.47
65.00	-284.71
70.00	-303.60
75.00	-339.34
80.00	-360.25
85.00	-393.72

Co BASE CAST (TURBINE) ALLOYS 03-02-002-140-4

WI-52 1038°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.57
15.00	1.77
30.00	0.28
45.00	-6.04
60.00	-14.91
75.00	-26.64
90.00	-42.72
100.00	-54.87

Co BASE CAST (TURBINE) ALLOYS 03-02-002-140-4

WI-52 1038°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.30A.
Cr_2O_3
CoO

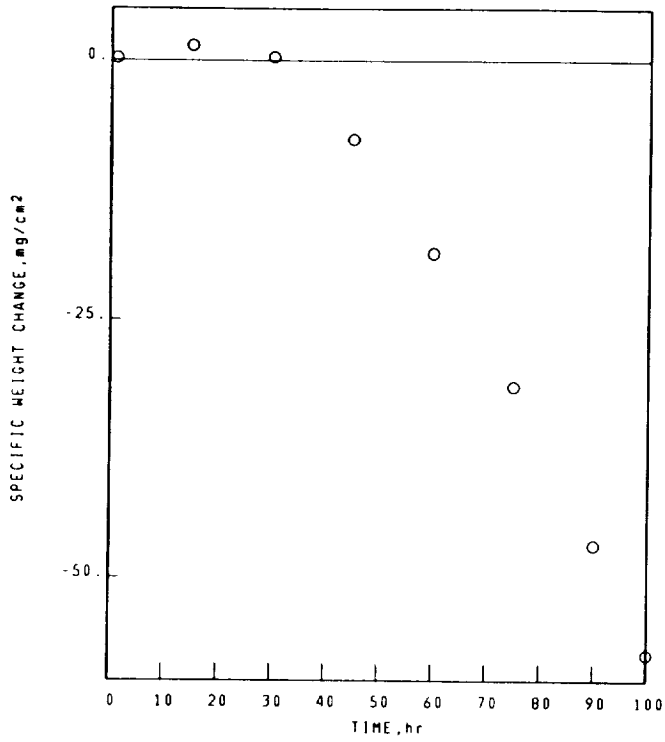
UNKNOWN LINES, d VALUES
1.76A.

SPALL
100 hr
COLLECTED SPALL
SPINEL, a_0=8.30A.
SPINEL, a_0=8.40A.

Co BASE CAST (TURBINE) ALLOYS 03-02-002-140-S

MI-52 1038°C 1.00hr CYCLES 100.00hr TEST 3.226mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

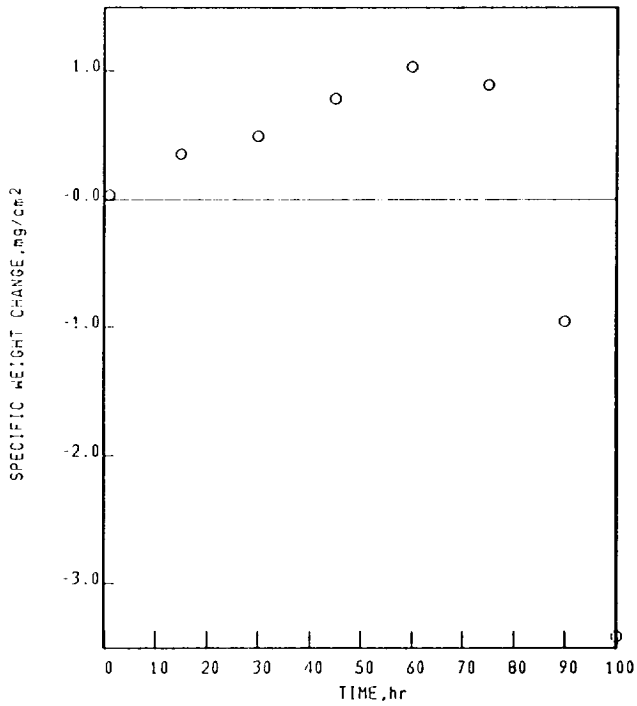


TIME, hr	ΔW/A, mg/cm^2
0.00	0.00
1.00	0.21
15.00	1.43
30.00	0.32
45.00	-7.66
60.00	-18.57
75.00	-31.48
90.00	-46.77
100.00	-57.43

Co BASE CAST (TURBINE) ALLOYS 03-02-002-104-1

WI-52 982°C 1.00hr CYCLES 100.00hr TEST 3.226mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.04
15.00	0.36
30.00	0.50
45.00	0.78
60.00	1.03
75.00	0.89
90.00	-0.96
100.00	-3.41

Co BASE CAST (TURBINE) ALLOYS 03-02-002-104-1

WI-52 982°C 1.00hr CYCLES 100.00hr TEST 3.226mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

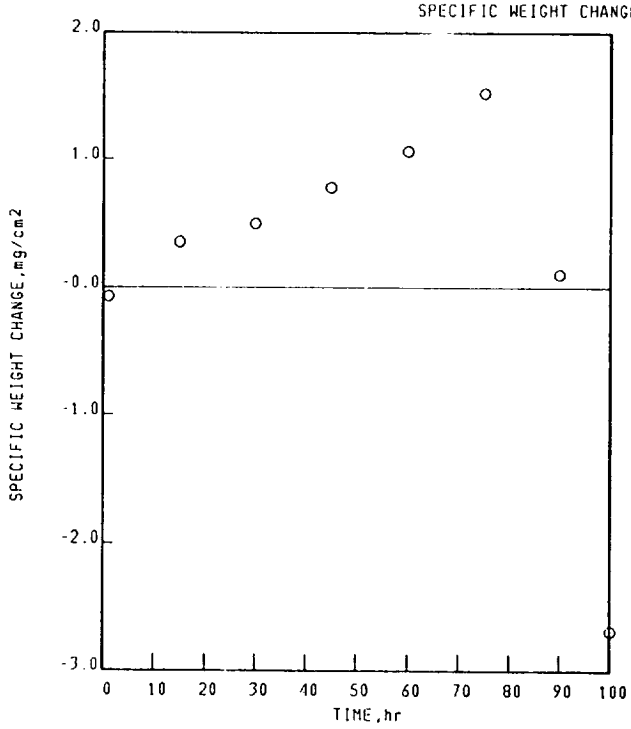
SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.30A.
Cr_2O_3
CoO

SPALL
100 hr
COLLECTED SPALL
CoO
SPINEL, a_0=8.30A.

Co BASE CAST (TURBINE) ALLOYS 03-02-002-104-2

WI-52 982°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

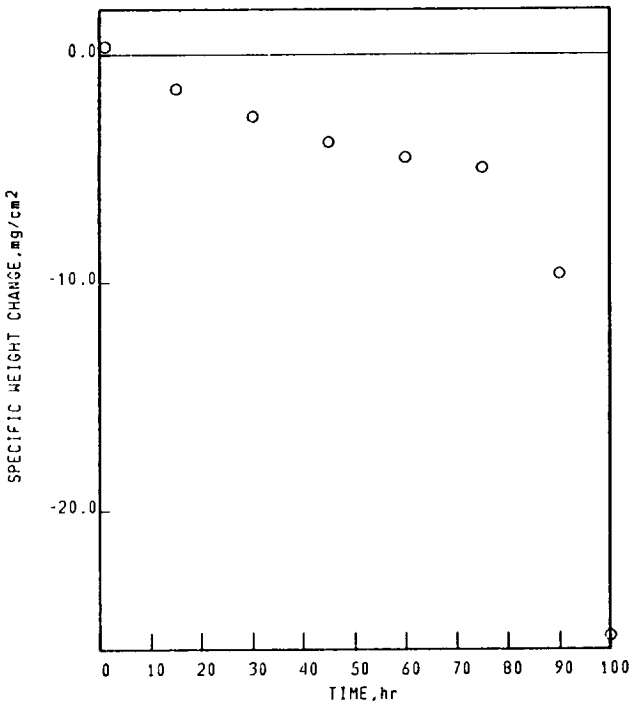


TIME,hr	ΔW/A,mg/cm²
0.00	0.00
1.00	-0.07
15.00	0.35
30.00	0.49
45.00	0.78
60.00	1.06
75.00	1.52
90.00	0.11
100.00	-2.69

Co BASE CAST (TURBINE) ALLOYS 03-02-001-095-5

X-40 1150°C 1.00hr CYCLES 100.00hr TEST 3.250mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

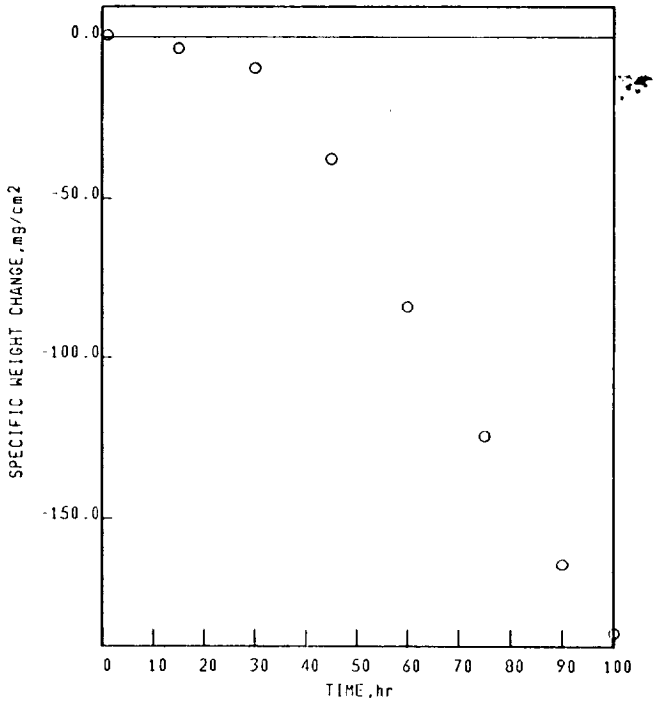


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.35
15.00	-1.48
30.00	-2.69
45.00	-3.82
60.00	-4.49
75.00	-4.95
90.00	-9.65
100.00	-25.44

Co BASE CAST (TURBINE) ALLOYS 03-02-001-095-4

X-40 1150°C 1.00hr CYCLES 100.00hr TEST 3.270mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm^2
0.00	0.00
1.00	0.63
15.00	-3.41
30.00	-9.64
45.00	-37.83
60.00	-84.11
75.00	-124.40
90.00	-164.27
100.00	-185.95

Co BASE CAST (TURBINE) ALLOYS 03-02-001-095-4

X-40 1150°C 1.00hr CYCLES 100.00hr TEST 3.270mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

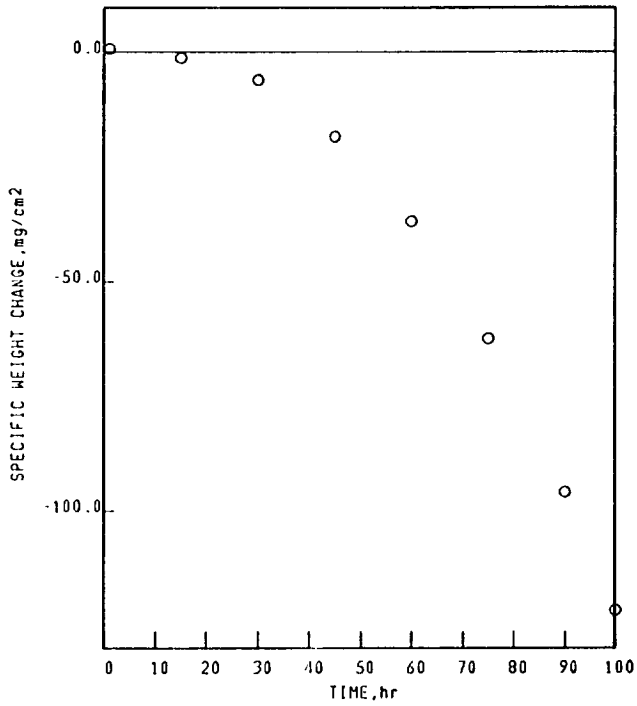
SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.25A.
Cr_2O_3

SPALL
100 hr
COLLECTED SPALL
CoO
SPINEL, a_0=8.25A.
SPINEL, a_0=8.20A.
Cr_2O_3

Co BASE CAST (TURBINE) ALLOYS 03-02-001-105-3

X-40 1150°C 1.00hr CYCLES 100.00hr TEST 2.521mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.75
15.00	-1.32
30.00	-6.12
45.00	-18.47
60.00	-36.83
75.00	-62.61
90.00	-95.96
100.00	-121.83

Co BASE CAST (TURBINE) ALLOYS 03-02-001-105-3

X-40 1150°C 1.00hr CYCLES 100.00hr TEST 2.521mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

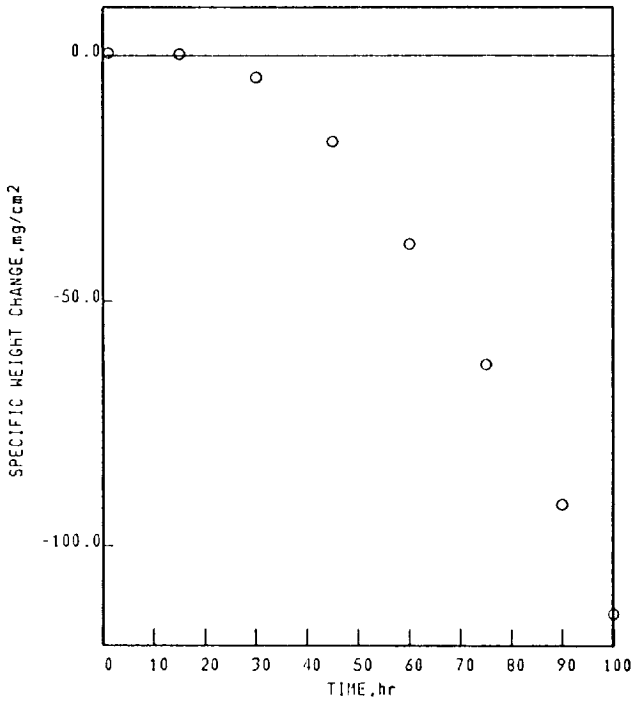
SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.35A.
Cr_2O_3
NiO
$Ni(W,Mo)O_4$ TYPE 1

SPALL
100 hr
COLLECTED SPALL
CoO

Co BASE CAST (TURBINE) ALLOYS 03-02-001-105-6

X-40 1150°C 1.00hr CYCLES 100.00hr TEST 2.568mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

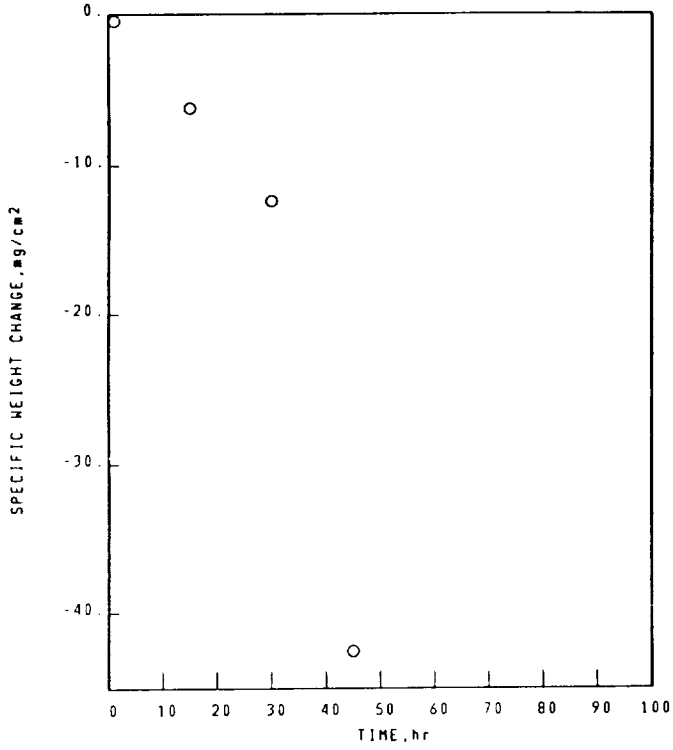


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.55
15.00	0.35
30.00	-4.43
45.00	-17.62
60.00	-38.52
75.00	-62.81
90.00	-91.53
100.00	-113.63

Co BASE CAST (TURBINE) ALLOYS 03-02-001-128-3

X-40 1150°C 1.00hr CYCLES 45.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

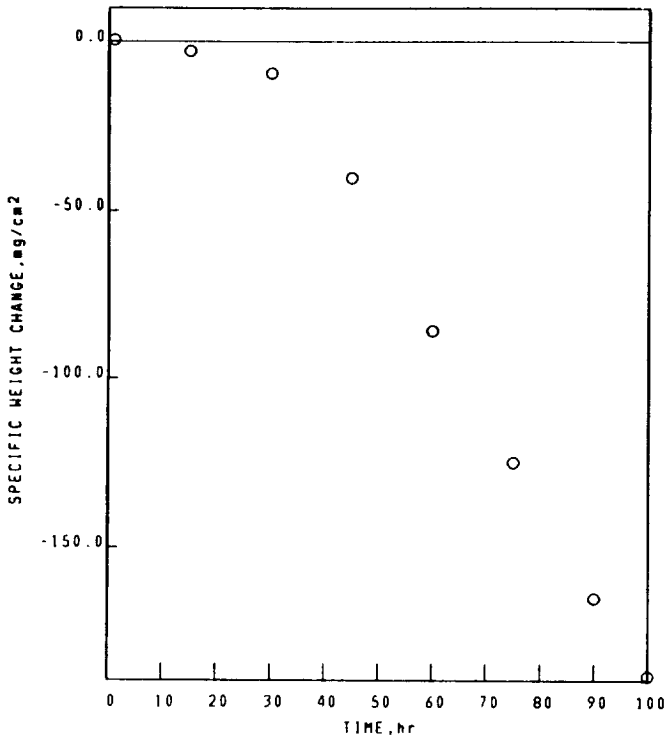


TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	-0.46
15.00	-6.16
30.00	-12.40
45.00	-42.54

Co BASE CAST (TURBINE) ALLOYS 03-02-001-128-6

X-40 1150°C 1.00hr CYCLES 100.00hr TEST 3.150mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

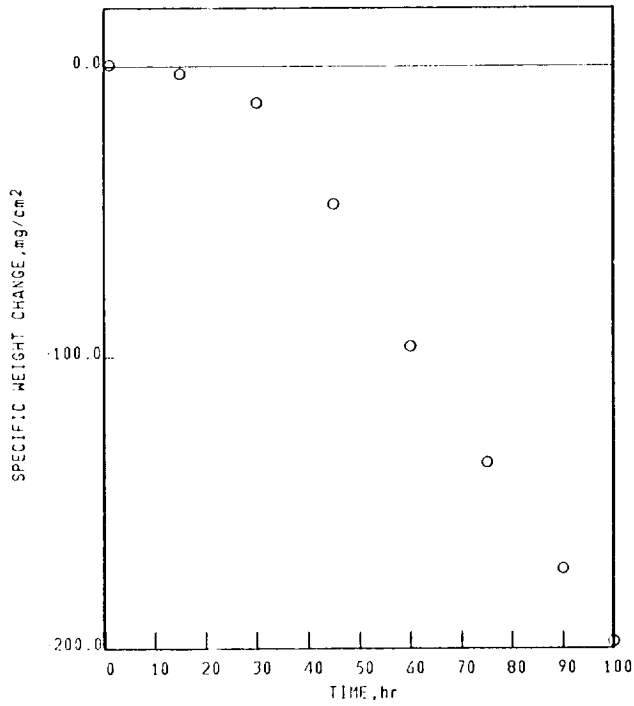


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.43
15.00	-2.87
30.00	-9.48
45.00	-40.58
60.00	-85.83
75.00	-125.04
90.00	-165.30
100.00	-188.64

Co BASE CAST (TURBINE) ALLOYS 03-02-001-146-3

X-40 1150°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

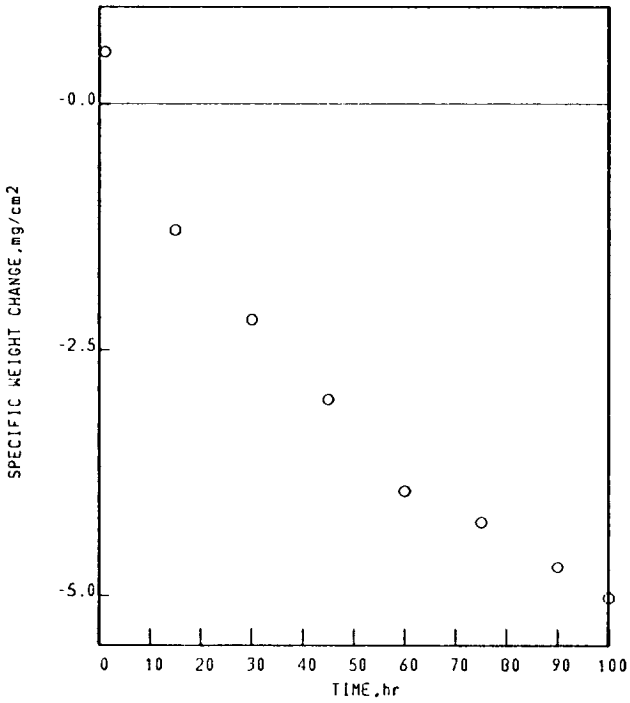


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.53
15.00	-2.47
30.00	-12.54
45.00	-47.66
60.00	-96.42
75.00	-136.53
90.00	-173.17
100.00	-197.87

Co BASE CAST (TURBINE) ALLOYS 03-02-001-096-4

X-40 1093°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.53
15.00	-1.27
30.00	-2.19
45.00	-3.00
60.00	-3.92
75.00	-4.24
90.00	-4.70
100.00	-5.02

Co BASE CAST (TURBINE) ALLOYS 03-02-001-096-4

X-40 1093°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

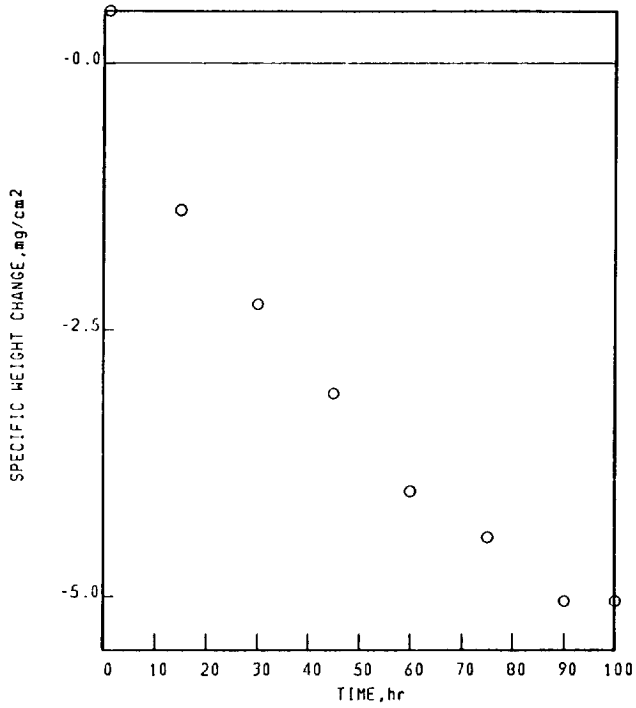
SURFACE
100 hr
STANDARD SURFACE
SPINEL, a_0=8.35A.

SPALL
100 hr
COLLECTED SPALL
CoO
SPINEL, a_0=8.35A.
Cr_2O_3

Co BASE CAST (TURBINE) ALLOYS 03-02-001-096-S

X-40 1093°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

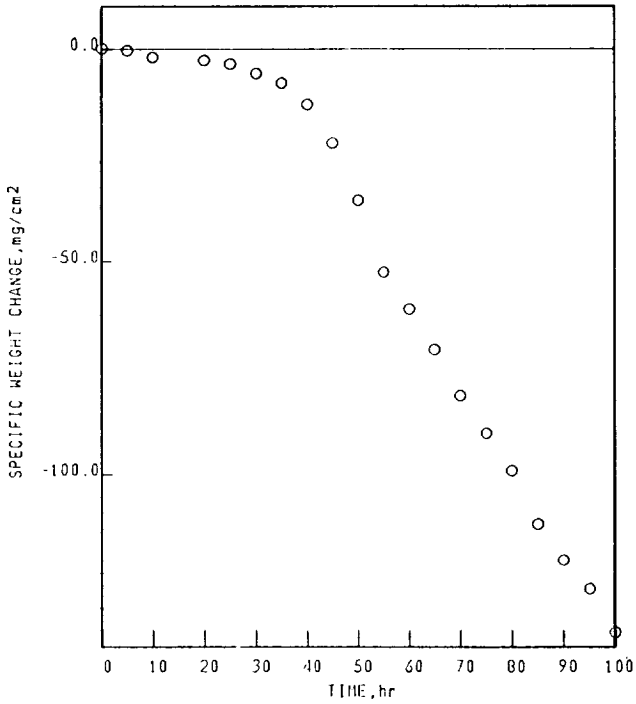


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.49
15.00	-1.37
30.00	-2.26
45.00	-3.10
60.00	-4.02
75.00	-4.44
90.00	-5.04
100.00	-5.04

Co BASE CAST (TURBINE) ALLOYS 03-02-001-131-S

X-40 1093°C 0.05hr CYCLES 100.00hr TEST 0.128mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm^2
0.00	0.00
0.05	0.18
5.00	-0.28
10.00	-1.91
20.00	-2.65
25.00	-3.46
30.00	-5.72
35.00	-7.95
40.00	-12.93
45.00	-22.08
50.00	-35.62
55.00	-52.51
60.00	-61.16
65.00	-70.49
70.00	-81.27
75.00	-90.13
80.00	-99.00
85.00	-111.55
90.00	-119.96
95.00	-126.74
100.00	-136.70

Co BASE CAST (TURBINE) ALLOYS 03-02-001-131-S

X-40 1093°C 0.05hr CYCLES 100.00hr TEST 0.128mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

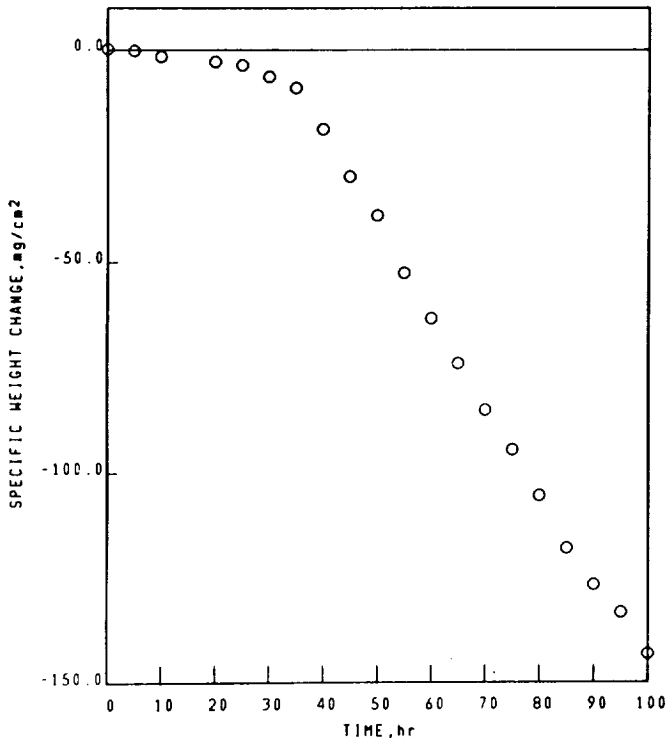
SURFACE
100 hr
STANDARD SURFACE
CoO
SPINEL, a_0=8.30A.
Cr_2O_3

SPALL
100 hr
SECOND SURFACE PHASE
SPINEL, a_0=8.45A.
CoO

Co BASE CAST (TURBINE) ALLOYS 03-02-001-131-4

X-40 1093°C 0.05hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

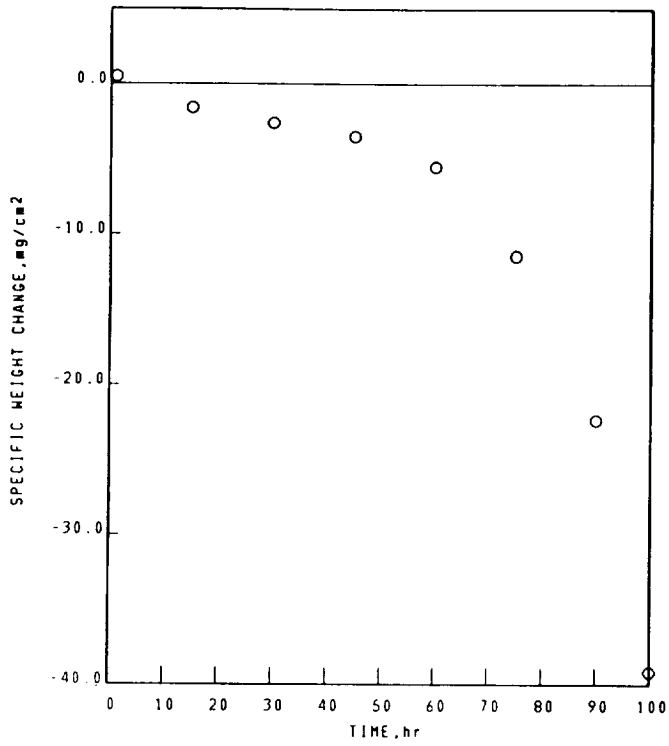


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
0.05	0.21
5.00	-0.21
10.00	-1.59
20.00	-2.83
25.00	-3.64
30.00	-6.32
35.00	-9.01
40.00	-18.73
45.00	-29.75
50.00	-39.04
55.00	-52.68
60.00	-63.64
65.00	-74.31
70.00	-85.44
75.00	-94.62
80.00	-105.50
85.00	-117.98
90.00	-126.67
95.00	-133.35
100.00	-143.21

Co BASE CAST (TURBINE) ALLOYS 03-02-001-143-S

X-40 1093°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

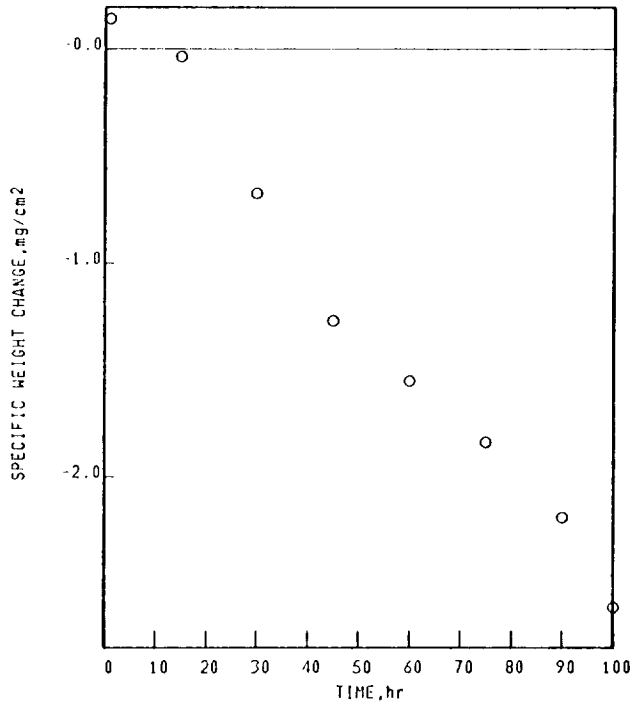


TIME, hr	ΔW/A, mg/cm²
0.00	0.00
1.00	0.49
15.00	-1.59
30.00	-2.61
45.00	-3.53
60.00	-5.55
75.00	-11.41
90.00	-22.37
100.00	-39.15

Co BASE CAST (TURBINE) ALLOYS 03-02-001-098-4

X-40 1038°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA

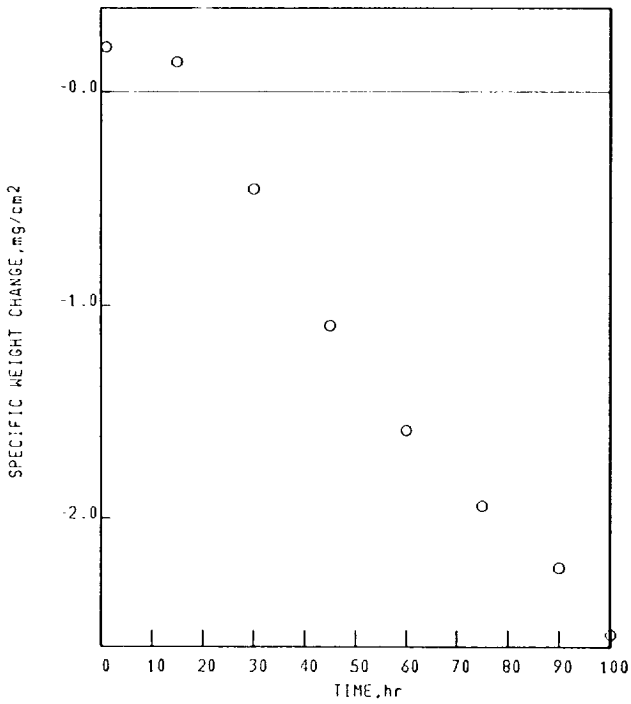


TIME,hr	ΔW/A,mg/cm^2
0.00	0.00
1.00	0.14
15.00	-0.04
30.00	-0.67
45.00	-1.27
60.00	-1.55
75.00	-1.84
90.00	-2.19
100.00	-2.61

Co BASE CAST (TURBINE) ALLOYS 03-02-001-098-5

X-40 1038°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

SPECIFIC WEIGHT CHANGE DATA



TIME, hr	ΔW/A, mg/cm^2
0.00	0.00
1.00	0.21
15.00	0.14
30.00	-0.46
45.00	-1.10
60.00	-1.59
75.00	-1.94
90.00	-2.23
100.00	-2.54

Co BASE CAST (TURBINE) ALLOYS 03-02-001 098-5

X-40 1038°C 1.00hr CYCLES 100.00hr TEST 3.251mm THICK STATIC AIR

X-RAY DIFFRACTION DATA

SURFACE
100 hr
STANDARD SURFACE
Cr_2O_3
SPINEL, a_0=8.30A.

FACE CENTERED CUBIC MATRIX

SPALL
100 hr
COLLECTED SPALL
SPINEL, a_0=8.25A.
Cr_2O_3

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15. Supplementary Notes

High-Temperature Cyclic Oxidation Data, Turbine Alloys, Part 2, by Charles A. Barrett and Carl E. Lowell, contains the remainder of the high-temperature, high-strength, nickel-base γ/γ' and cobalt-base turbine alloys tested at Lewis, and is available as NASA TM-101468.

16. Abstract

To make the large body of cyclic oxidation data collected at the NASA Lewis Research Center widely available, Lewis is publishing a series of cyclic oxidation handbooks. This first part in that series contains specific-weight-change-versus-time data and x-ray diffraction results derived from high-temperature cyclic tests on high-temperature, high-strength nickel-base γ/γ' and cobalt-base turbine alloys. Each page of data summarizes a complete test on a given alloy sample.

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