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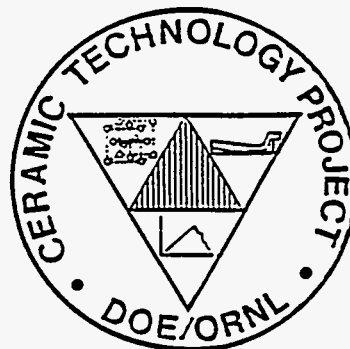
LOCKHEED MARTIN 

**Life Prediction Methodology for Ceramic
Components of Advanced Vehicular
Heat Engines**

**Volume III - Final Report
Appendices III, IV, V, VI, and VII**

**P. K. Khandelwal
N. J. Provenzano
W. E. Schneider**

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DEPARTMENT OF ENERGY

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LIFE PREDICTION METHODOLOGY FOR CERAMIC COMPONENTS OF
ADVANCED VEHICULAR HEAT ENGINES

P. K. Khandelwal
N. J. Provenzano
W. E. Schneider

Date Published: February 1996

VOLUME III - FINAL REPORT
APPENDICES III, IV, V, VI, and VII

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Research sponsored by the U.S. Department of Energy, Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Transportation Technologies, as part of the Propulsion Systems Materials Program, under contract DE-AC05-96OR22464 with Lockheed Martin Energy Research Corporation.

APPENDIX III

**DYNAMIC FATIGUE TESTING OF MOR SPECIMENS IN AIR AT ALLISON FROM
1000°C TO 1400°C**

MATERIAL: GTE PY6 SILICON NITRIDE
 SPECIMEN: MIL STD. 1942 SPECIMEN 'B'
 PROCESS: INJECTION MOLDED AND HIP'ED
 DIMENSIONS: 3*4*50 MM
 TEMP.: 1000 DEG.C

SPECIMEN NUMBER	LOT NUMBER	WIDTH MM	THICKNESS MM	STROKE RATE MM/MIN	FAILURE	FAILURE	FAILURE	STRESS RATE MPa/Sec	ORIGIN		FAILURE ORIGIN
					STRENGTH KSI	STRENGTH MPa	TIME SEC		X MM	Y MM	
34.1526	Q21-19	4.023	2.992	0.508	96.72	666.88	47.4	14.069	31.8	0.2	SFC
34.1527	Q21-19	4.023	2.995	0.508	92.26	636.16	46.2	13.770	30.0	0.2	SFC
34.1528	Q21-19	4.026	3.020	0.508	88.55	610.57	44.1	13.845	26.5	3.8	SFC
34.1529	Q21-19	4.026	3.007	0.508	121.20	835.65	57.6	14.508	22.0	3.3	IP
34.1530	Q21-19	4.026	3.015	0.508	111.59	769.44	50.1	15.358	31.9	0.2	SFC
34.1725	Q21-90-42	4.013	3.018	0.508	119.17	821.70	54.0	15.217	17.0	0.2	SFC
34.1726	Q21-90-42	4.006	3.018	0.508	123.11	848.88	55.8	15.213	12.0	1.2	II
34.1727	Q21-90-42	4.008	3.018	0.508	98.11	676.34	46.8	14.452	25.7	0.2	SFC
34.1728	Q21-90-42	4.008	3.015	0.508	90.84	628.34	48.0	13.090	30.4	0.3	SF
34.1729	Q21-90-42	4.008	3.015	0.508	123.78	853.43	55.8	15.294	33.1	2.1	SF
34.1811	Q21-90-42	3.995	3.002	0.508	101.57	700.36	47.4	14.776	34.2	3.8	SFC
AVERAGE					106.08	731.61	50.29	14.51			
STD. DEV.					13.26	91.26	4.44	0.71			
34.1440	Q21-19	4.028	3.000	0.0508	111.59	769.42	414	1.859	17.2	0.0	SFC
34.1441	Q21-19	4.026	3.015	0.0508	109.48	754.85	474	1.593	29.2	2.0	SF
34.1442	Q21-19	4.023	2.992	0.0508	58.03	400.13	264	1.516	14.5	0.2	SFC
34.1443	Q21-19	4.026	3.015	0.0508	99.43	658.56	444	1.483	33.2	0.5	SF
34.1444	Q21-19	3.005	2.992	0.0508	95.71	659.89	444	1.486	18.2	0.8	SFC
34.1941	Q21-90-42	3.985	3.007	0.0508	111.16	776.42	510	1.522	31.6	1.2	SF
34.1942	Q21-90-42	3.985	3.010	0.0508	118.47	816.87	528	1.547	35.9	1.9	SF
34.1943	Q21-90-42	3.985	3.010	0.0508	99.17	683.81	492	1.390	34.8	0.3	SF
34.1944	Q21-90-42	3.983	3.010	0.0508	107.28	739.72	504	1.468	31.1	3.8	SFC
34.1945	Q21-90-42	3.985	3.005	0.0508	114.03	786.26	480	1.638	29.0	0.2	SFC
AVERAGE					102.44	704.59	455	1.55			
STD. DEV.					16.31	113.86	71.77	0.12			
34.1829	Q21-90-42	4.054	3.010	0.00508	70.76	487.90	2862	0.170	20.3	0.4	SF
34.1830	Q21-90-42	3.988	3.015	0.00508	94.51	651.67	3816	0.171	21.1	0.2	SFC
34.1832	Q21-90-42	3.983	3.012	0.00508	70.69	487.39	3078	0.158	28.3	3.8	SFC
34.1833	Q21-90-42	3.983	3.012	0.00508	90.12	621.37	2316	0.268	29.6	0.7	SI
34.1836	Q21-90-42	3.983	3.010	0.00508	92.11	635.09	3360	0.189	38.6	0.2	SFC
34.1837	Q21-90-42	3.983	3.015	0.00508	93.72	646.17	3042	0.212	18.8	3.7	SF
34.1838	Q21-90-42	3.980	3.010	0.00508	73.37	505.86	1866	0.271	17.2	4.0	SFC
34.1839	Q21-90-42	3.983	3.012	0.00508	88.33	609.01	2472	0.246	21.5	3.8	SFC
34.1840	Q21-90-42	3.983	3.012	0.00508	94.63	652.47	3780	0.173	32.4	4.0	SFC
34.1841	Q21-90-42	3.983	3.012	0.00508	100.01	689.54	3360	0.205	25.2	1.0	SF
34.1842	Q21-90-42	3.980	3.005	0.00508	97.26	670.58	4338	0.155	35.6	0.2	SFC
AVERAGE					87.77	605.19	3117	0.20			
STD. DEV.					10.36	71.44	690	0.04			

MATERIAL:GTE PY6 SILICON NITRIDE
 SPECIMEN:MIL STD. 1942 SPECIMEN 'B'
 PROCESS:INJECTION MOLDED AND HIP'ED
 DIMEN.:3*4*50mm
 TEMP:1200 DEG. C.

SPECIMEN NUMBER	LOT NUMBER	WIDTH mm	THICKNESS mm	STROKE RATE mm/MIN	FAILURE	FAILURE	FAILURE TIME SEC	STRESS RATE MPa/SEC	ORIGIN		TYPE
					STRENGTH KSI	STRENGTH MPa			X MM	Y MM	
34.1647	Q21-90-34	4.016	3.012	0.508	83.46	575.42	45	12.7871	21.3	0.0	SFC
34.1648	Q21-90-34	4.006	3.010	0.508	98.50	679.19	48	14.1498	31.5	3.6	II
34.1649	Q21-90-34	4.008	3.012	0.508	72.54	500.14	39	12.8241	15.1	3.7	SF
34.1650	Q21-90-34	4.006	3.010	0.508	92.96	640.99	48	13.3540	18.1	1.8	SF
34.1651	Q21-90-34	4.006	3.010	0.508	96.68	666.63	54	12.3450	16.5	2.6	SF
34.1652	Q21-90-34	4.006	3.010	0.508	99.04	682.86	54	12.6456	15.1	0.3	SF
34.1653	Q21-90-34	4.008	3.007	0.508	89.94	599.43	46	13.0311	15.5	1.4	II
34.1654	Q21-90-34	4.008	3.012	0.508	94.94	654.59	50	13.0918	25.4	1.4	SF
34.1765	Q21-90-34	4.001	3.010	0.508	75.83	522.87	39	13.4069	29.3	0.2	SFC
34.1766	Q21-90-34	4.011	3.020	0.508	93.65	645.73	40	16.1433	27.2	3.8	SFC
34.1767	Q21-90-34	4.003	3.010	0.508	98.73	680.77	43	15.8319	30.3	0.2	SFC
34.1769	Q21-90-34	4.001	3.010	0.508	91.32	629.42	47	13.3919	23.5	1.7	SF
34.1771	Q21-90-34	4.001	3.007	0.508	100.57	693.42	43	16.1260	28.0	1.6	SF
34.1772	Q21-90-34	4.003	3.005	0.508	79.25	546.46	37	14.7692	36.6	0.2	SF
34.1774	Q21-90-34	4.001	3.007	0.508	78.64	542.19	43	12.6091	33.8	3.5	SF
34.1775	Q21-90-34	4.001	3.007	0.508	65.80	453.67	31	14.6345	32.8	0.2	SFC
34.1776	Q21-90-34	4.008	3.015	0.508	102.53	706.92	45	15.7093	22.6	1.8	IP
34.1777	Q21-90-34	4.006	3.015	0.508	88.24	608.41	39	15.6003	19.1	3.8	SFC
				AVERAGE	89.03	612.73	44	14.03			
				STD.DEV.	10.43	71.95	6	1.32			
34.1455	Q21-19	4.006	3.012	0.0508	72.98	503.19	306	1.6444	18.6	0.6	SF
34.1456	Q21-19	4.011	3.015	0.0508	95.79	660.45	432	1.5288	34.4	0.2	II
34.1457	Q21-19	4.016	3.015	0.0508	91.88	633.48	348	1.8203	33.8	0.5	SF
34.1458	Q21-19	4.013	3.023	0.0508	102.28	705.20	450	1.5671	28.0	2.9	SF
34.1459	Q21-19	3.998	3.005	0.0508	96.66	666.49	396	1.6831	20.9	0.8	II
34.1806	Q21-90-42	4.003	3.007	0.0508	71.68	494.24	378	1.3075	28.6	3.8	SFC
34.1807	Q21-90-42	4.006	3.007	0.0508	76.19	525.33	414	1.2689	33.8	0.2	SFC
34.1808	Q21-90-42	4.013	3.018	0.0508	91.95	634.00	432	1.4676	18.4	2.5	SF
34.1809	Q21-90-42	4.006	3.012	0.0508	97.96	675.40	402	1.6801	30.2	1.3	SF
34.1810	Q21-90-42	4.006	3.015	0.0508	97.42	671.71	426	1.5768	16.9	0.7	
				AVERAGE	89.48	616.95	398	1.55			
				STD.DEV.	10.81	74.50	41.76	0.16			
34.2228	Q21-90-64	4.016	3.038	0.00508	88.37	609.29	7140	0.0853	36.1	1.5	SF
34.2020	Q21-90-64	4.031	3.000	0.00508	75.29	519.13	6060	0.0857	15.7	2.3	SF
34.2152	Q21-90-64	4.016	3.030	0.00508	78.73	542.87	5880	0.0923	33.3	0.2	II
34.2154	Q21-90-64	4.018	3.030	0.00508	72.60	500.58	5280	0.0948	30.4	3.7	II
34.2155	Q21-90-64	4.016	3.030	0.00508	81.67	563.14	4650	0.1211	34.4	1.0	SF
34.2156	Q21-90-64	4.016	3.038	0.00508	63.93	440.77	5400	0.0816	36.8	2.0	SI
34.2157	Q21-90-64	4.016	3.007	0.00508	68.33	471.15	7380	0.0638	31.2	3.9	SFC
34.2158	Q21-90-64	4.016	3.030	0.00508	85.45	589.20	6780	0.0869	22.0	0.2	SFC
				AVERAGE	76.80	529.52	6071.25	0.09			
				STD.DEV.	7.85	54.16	900.74	0.01			

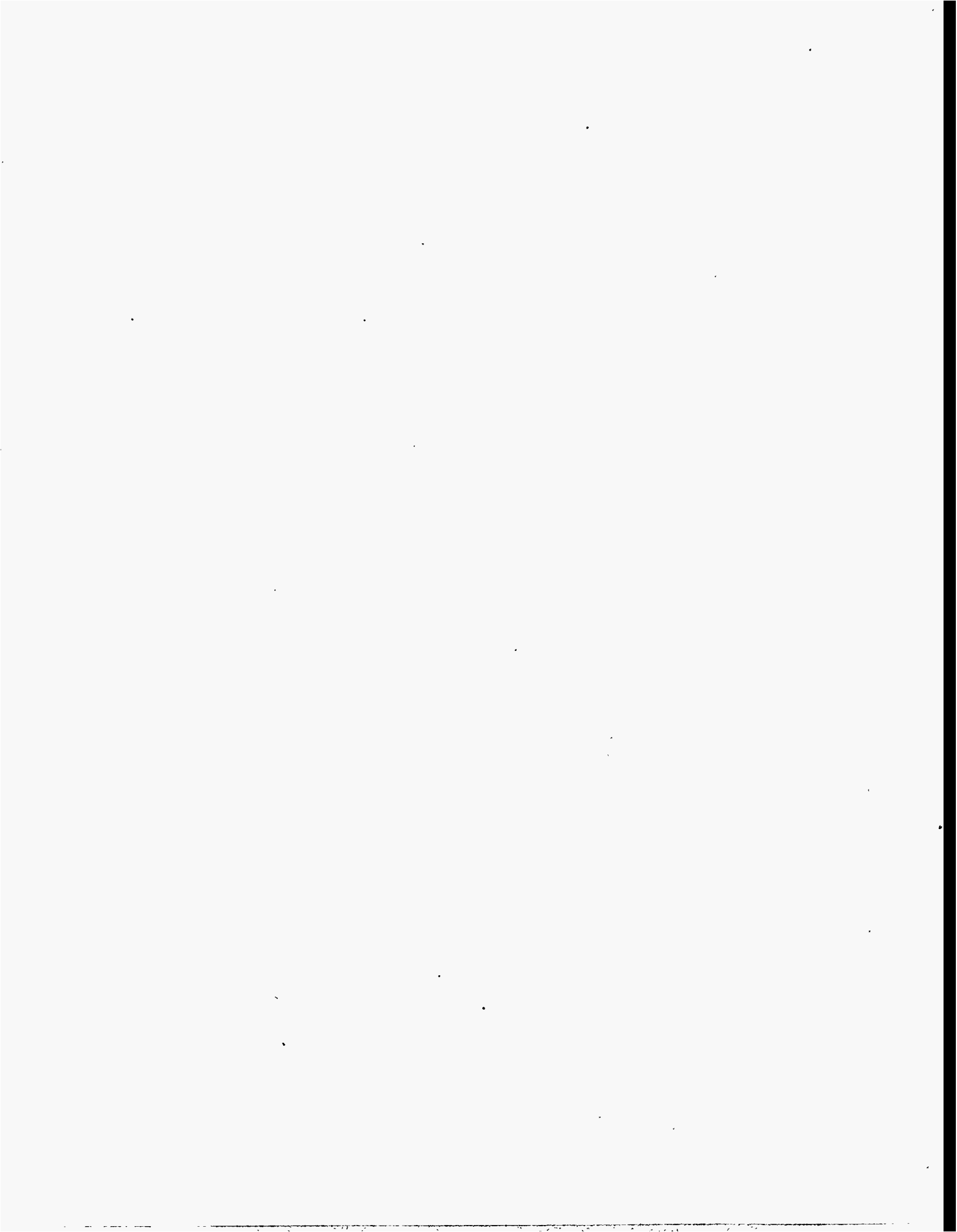
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 SPECIMEN:MIL STD. 1942 SPECIMEN 'B'
 PROCESS:INJECTION MOLDED AND HIP'ED
 DIMEN.:3*4*50mm
 TEMP:1300 DEG. C.

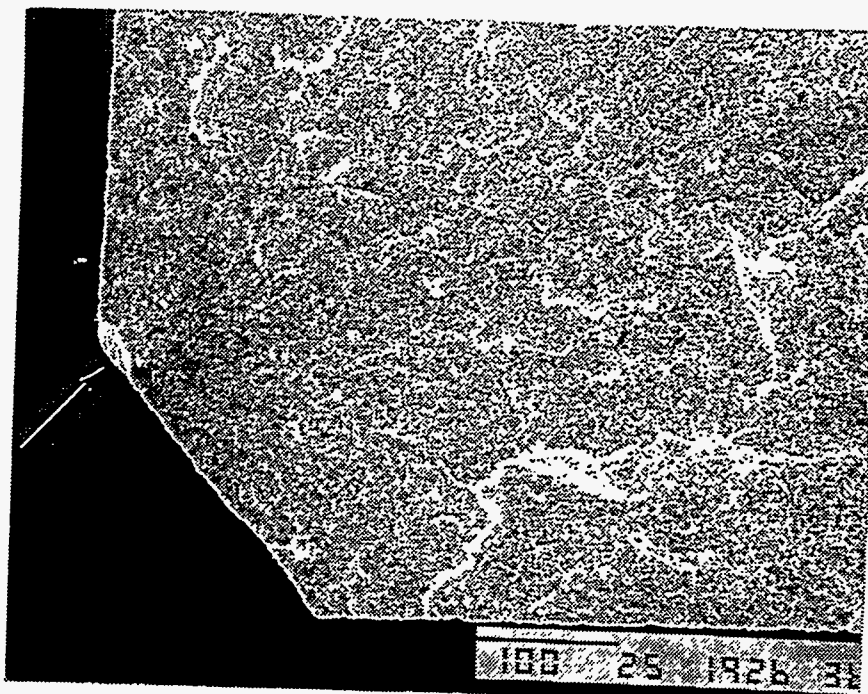
SPECIMEN NUMBER	LOT NUMBER	WIDTH mm	THICKNESS mm	STROKE RATE mm/MIN	FAILURE STRENGTH KSI	FAILURE STRENGTH MPa	FAILURE STRESS		ORIGIN		TYPE
							TIME SEC	RATE MPa/SEC	X MM	Y MM	
34.1635	Q21-90-34	4.003	3.007	0.508	76.45	527.11	46	11.4589	27.3	3.5	SF
34.1638	Q21-90-34	4.006	3.012	0.508	88.92	613.11	48	12.7731	36.2	1.3	II
34.1640	Q21-90-34	4.016	3.015	0.508	98.09	676.33	54	12.5246	21.3	3.6	SI
34.1641	Q21-90-34	4.013	3.023	0.508	80.77	556.88	48	11.6017	24.1	3.3	II
34.1642	Q21-90-34	3.998	3.005	0.508	73.46	506.49	42	12.0593	33.2	0.2	SFC
34.1643	Q21-90-34	4.003	3.007	0.508	84.47	582.40	54	10.7852	17.2	0.4	IP
34.1644	Q21-90-34	4.006	3.007	0.508	56.10	386.79	42	9.2093	19.5	1.3	II
34.1760	Q21-90-42	4.001	3.007	0.508	88.26	608.58	48	12.6788	19.3	1.9	SF
34.1761	Q21-90-42	4.003	3.005	0.508	89.96	620.30	54	11.4870	28.2	1.2	SF
34.1762	Q21-90-42	4.003	3.007	0.508	78.59	541.85	38	14.2592	33.9	3.7	SF
34.1763	Q21-90-42	4.003	3.010	0.508	83.53	603.49	44	13.7157	35.1	3.4	SF
34.1764	Q21-90-42	4.001	3.010	0.508	85.98	592.83	42	14.1150	24.4	3.8	SFC
				AVERAGE	82.05	568.01	47	12.222			
				STD.DEV.	10.09	70.32	5	1.392			
34.2013	Q21-90-64	3.988	2.995	0.00508	59.10	407.49	9300	0.0438	33.9	0.5	SF
34.2014	Q21-90-64	4.028	2.995	0.00508	55.72	384.17	11280	0.0341	36.7	3.8	SF
34.2015	Q21-90-64	4.034	3.002	0.00508	49.40	340.63	7440	0.0458	16.9	0.5	SF
34.2016	Q21-90-64	4.034	3.002	0.00508	60.26	415.51	9300	0.0447	26.5	2.1	SF
34.2018	Q21-90-64	3.988	2.995	0.00508	62.78	432.86	5100	0.0849	28.3	1.9	SF
34.2019	Q21-90-64	4.028	3.000	0.00508	48.91	337.23	9420	0.0358	23.8	3.5	SF
				AVERAGE	56.03	386.32	8640	0.05			
				STD.DEV.	5.29	36.44	1933	0.02			

MATERIAL:GTE PY6 SILICON NITRIDE
 SPECIMEN:MIL STD. 1942 SPECIMEN 'B'
 PROCESS: INJECTION MOLDED AND HIP'ED
 DIMEN.: 3*4*50mm
 TEMP: 1400 DEG. C.

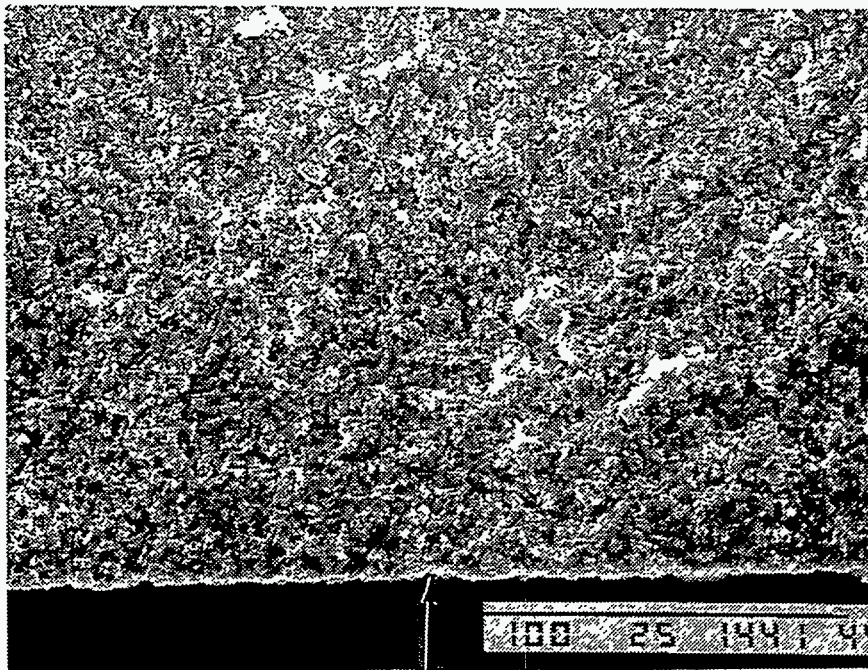
SPECIMEN NUMBER	LOT NUMBER	WIDTH mm	THICKNESS mm	STROKE RATE mm/MIN	FAILURE	FAILURE	FAILURE	STRESS RATE MPa/SEC	ORIGIN		FAILURE
					STRENGTH KSI	STRENGTH MPa	TIME SEC		X MM	Y MM	ORIGIN
34.1797	Q21-90-42	4.003	3.007	0.508	72.71	501.30	47	10.6660	30.8	0.3	SF
34.1799	Q21-90-42	4.006	3.002	0.508	61.65	425.06	41	10.3673	30.4	3.1	IP
34.1884	Q21-90-42	3.983	3.012	0.508	67.47	465.24	41	11.3473	19.0	1.2	SF
34.1886	Q21-90-42	3.988	3.018	0.508	59.70	441.63	44	10.0370	26.5	0.5	SF
34.1887	Q21-90-42	3.988	3.018	0.508	62.36	430.01	45	9.5558	30.4	3.1	SF
34.1888	Q21-90-42	3.988	3.020	0.508	64.39	443.96	43	10.3247	21.7	0.7	SF
34.1889	Q21-90-42	3.988	3.018	0.508	63.43	437.36	39	11.2144	19.4	0.5	SF
34.1890	Q21-90-42	3.988	3.015	0.508	64.61	445.46	42	10.6062	25.6	0.8	SF
34.1891	Q21-90-42	3.988	3.020	0.508	65.98	454.97	47	9.6802	34.7	0.3	SF
34.1893	Q21-90-42	3.988	3.012	0.508	65.78	453.58	47	9.6506	27.3	1.8	SF
34.1894	Q21-90-42	3.985	3.015	0.508	71.06	489.95	43	11.3942	27.8	0.3	SF
34.1895	Q21-90-42	3.983	3.015	0.508	70.03	482.89	46	10.4976	32.8	0.3	II
34.1896	Q21-90-42	3.983	3.012	0.508	65.33	450.47	38	11.8545	33.2	3.2	SF
34.1897	Q21-90-42	3.980	3.012	0.508	70.20	484.01	42	11.5240	26.5	3.5	SF
34.1898	Q21-90-42	3.980	3.012	0.508	59.48	410.11	36	11.3919	26.6	2.1	SF
34.1899	Q21-90-42	3.980	3.010	0.508	62.76	432.79	38	11.3892	31	0.5	SF
34.1900	Q21-90-42	3.980	3.012	0.508	60.51	417.24	40	10.4310	28.5	0.4	SF
			AVERAGE		65.14	450.94	42	10.702			
			STD.DEV.		3.92	25.43	3	0.703			
34.1470	Q21-19	3.980	3.025	0.0508	52.50	361.99	348	1.0402	31.5	3.8	SFC
34.1471	Q21-19	3.980	3.012	0.0508	57.22	394.50	354	1.1144	27.6	0.2	SFC
34.1472	Q21-19	3.980	3.015	0.0508	60.78	419.10	378	1.1087	14.2	2.9	SF
34.1473	Q21-19	3.980	3.000	0.0508	50.69	349.52	258	1.3547	29.0	3.8	SFC
34.1474	Q21-19	3.980	2.995	0.0508	56.40	388.84	444	0.8758	33.8	1.0	SF
34.1800	Q21-90-42	3.980	3.007	0.0508	53.46	368.61	648	0.5688	17.8	0.2	SFC
34.1803	Q21-90-42	3.980	3.005	0.0508	52.51	362.07	474	0.7639	16.2	0.2	SFC
34.1805	Q21-90-42	3.980	3.007	0.0508	52.93	362.07	414	0.8746	16.2	0.2	SFC
			AVERAGE		54.56	375.84	415	0.963			
			STD.DEV.		3.09	21.52	108	0.227			
34.2223	Q21-90-64	3.980	3.038	0.00508	41.15	283.76	8520	0.0333	32.5	0.8	SF
34.2222	Q21-90-64	3.980	3.033	0.00508	48.27	332.83	7560	0.0440	29.6	0.1	SFC
34.2221	Q21-90-64	3.980	3.030	0.00508	50.42	347.66	11580	0.0300	31.3	3.8	SFC
34.2193	Q21-90-64	3.980	3.038	0.00508	42.20	290.96	8280	0.0351	21.6	3.3	SF
34.2192	Q21-90-64	3.980	3.038	0.00508	41.75	287.90	14280	0.0202	20.9	3.4	SF
34.2191	Q21-90-64	3.980	3.033	0.00508	44.02	303.50	15420	0.0197	19.7	2.5	SF
34.2230	Q21-90-64	3.980	3.045	0.00508	50.89	350.92	9300	0.0377	25.8	3.5	SF
34.2229	Q21-90-64	3.980	3.035	0.00508	52.28	360.48	10800	0.0334	20.7	3.8	SFC
34.2224	Q21-90-64	3.980	3.033	0.00508	46.68	642.52	9240	0.0695	21.5	2.2	SF
34.2225	Q21-90-64	3.980	3.035	0.00508	39.60	273.40	9840	0.0278	17.1	0.2	SFC
			AVERAGE		45.73	347.39	10482	0.035			
			STD.DEV.		4.34	102.80	2464	0.013			

1000°C MOR SPECIMENS

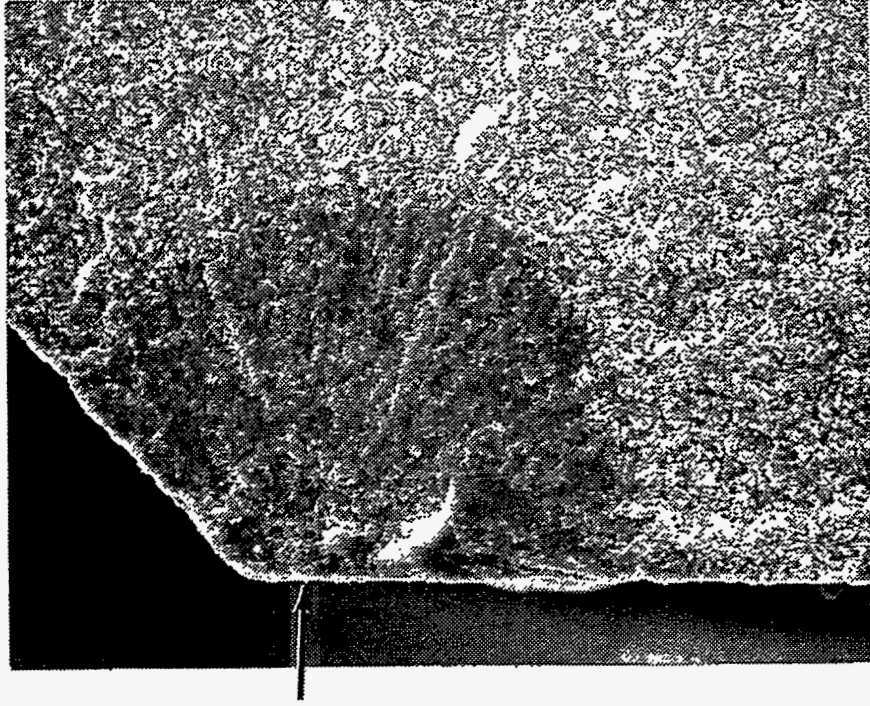




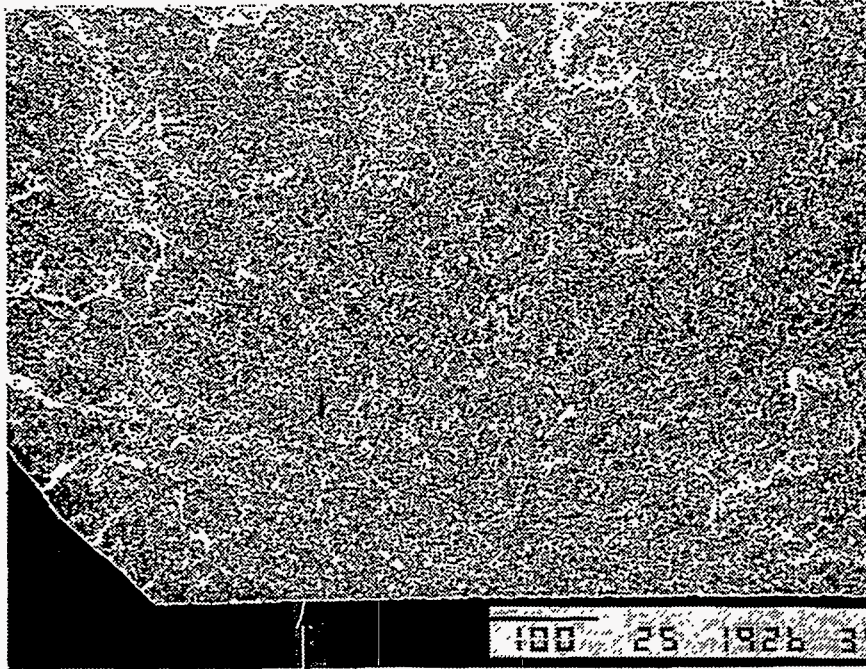
Specimen Number: 34.1440



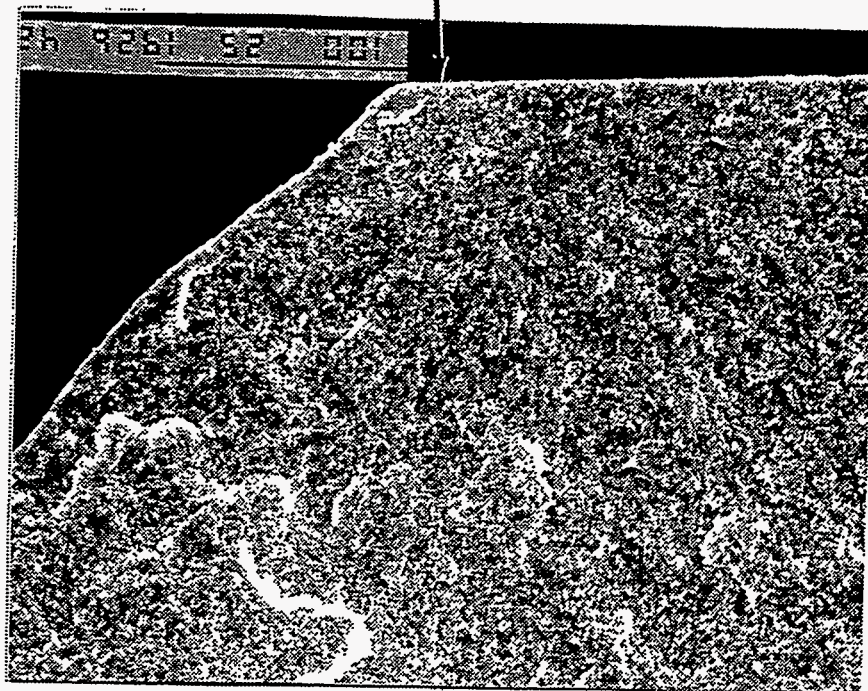
Specimen Number: 34.1441



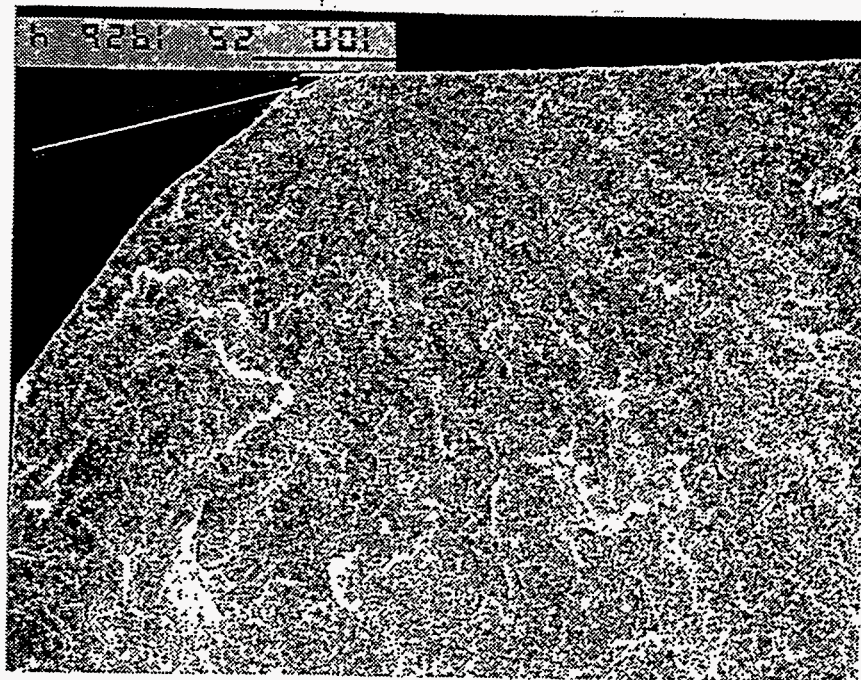
Specimen Number: 34.1442

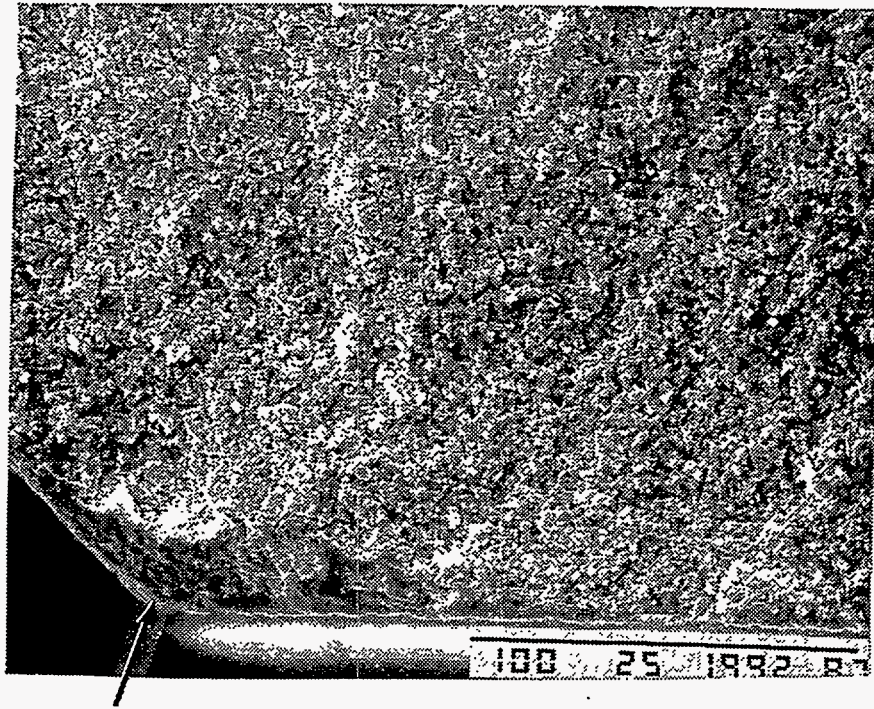


Specimen Number: 34.1443

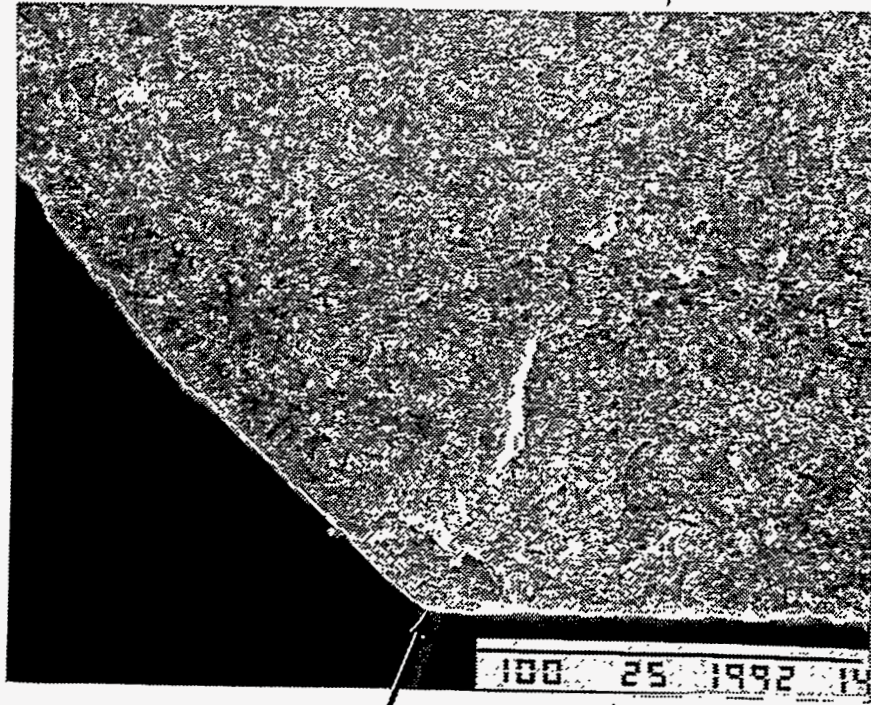


Specimen Number: 34.1444

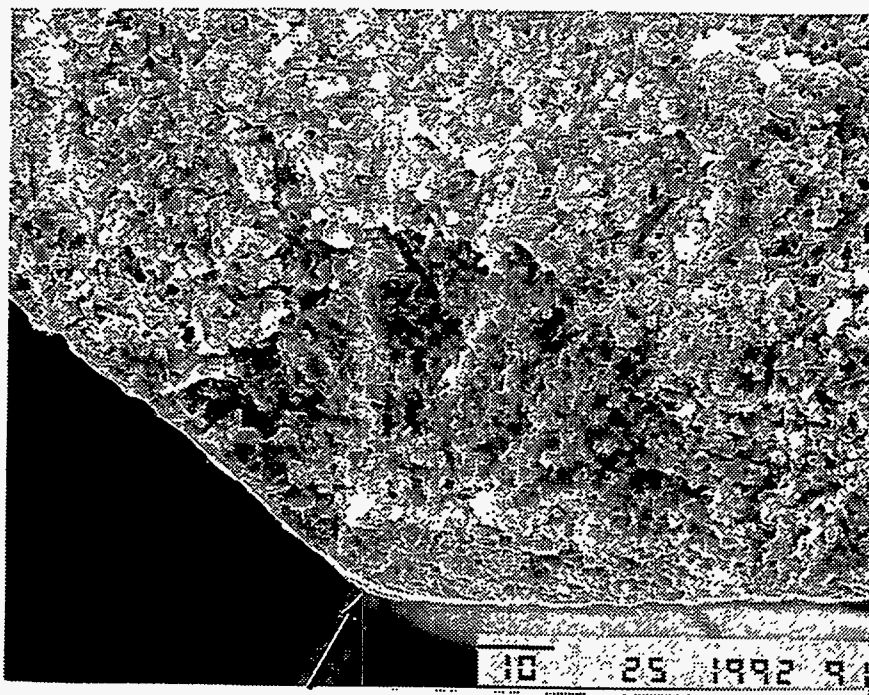




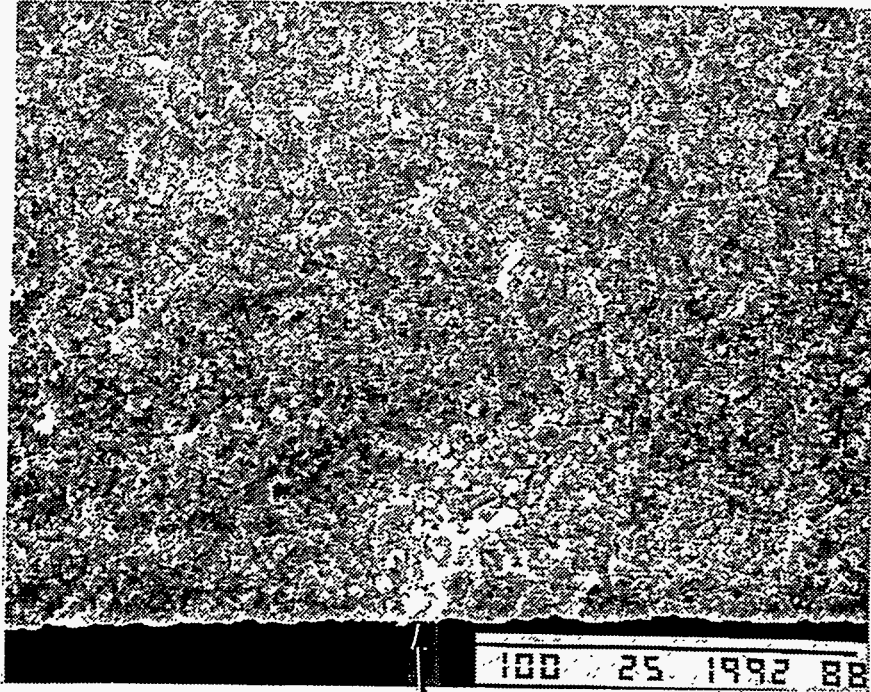
Specimen Number: 34.1829



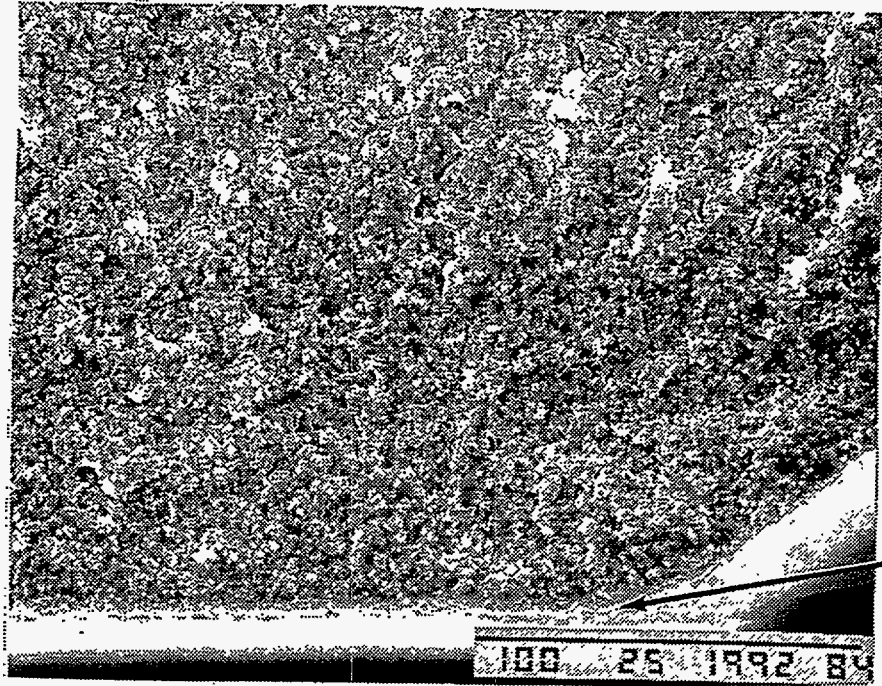
Specimen Number: 34.1830



Specimen Number: 34.1832

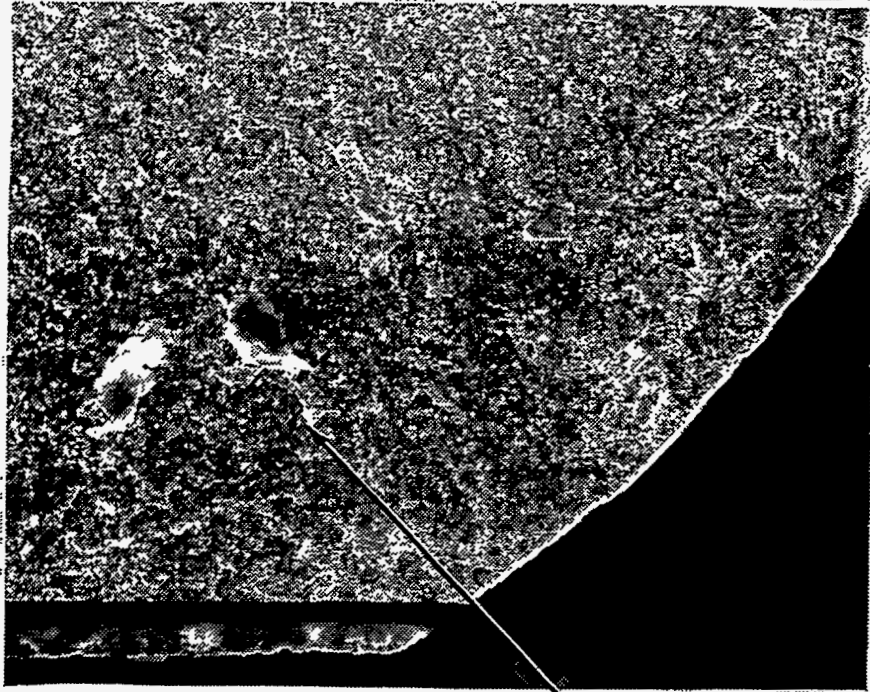


Specimen Number: 34.1833

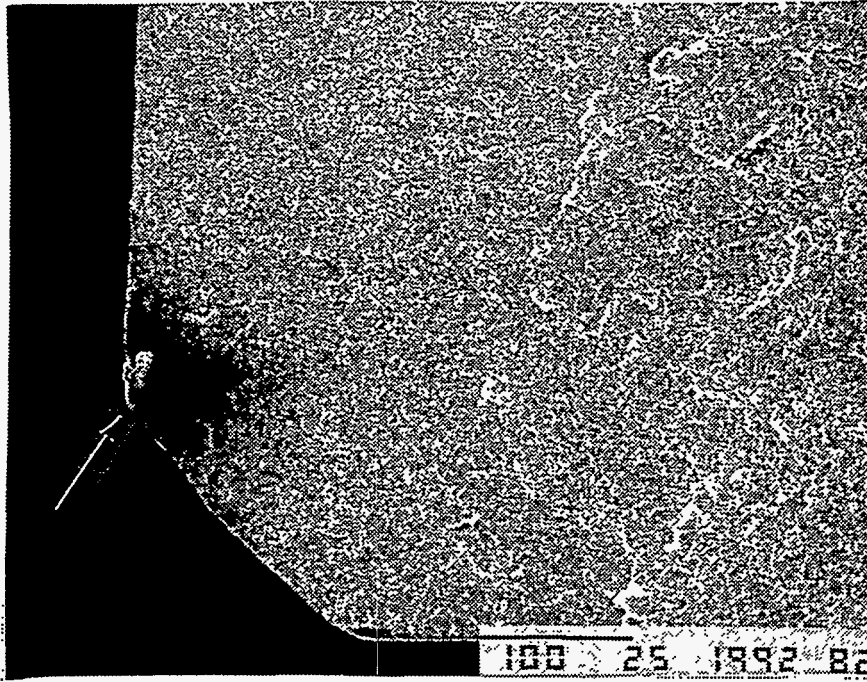


Specimen Number: 34.1837

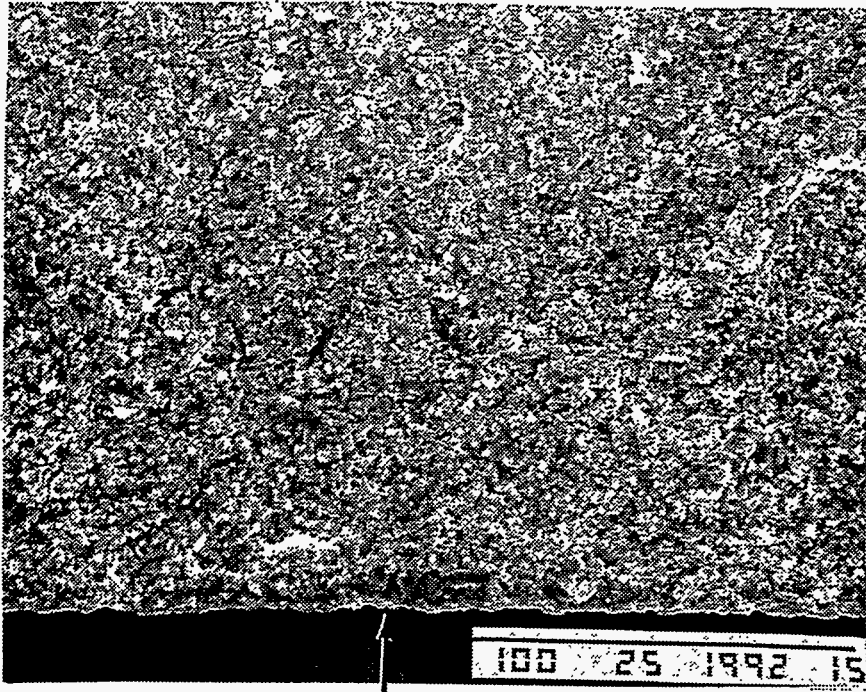




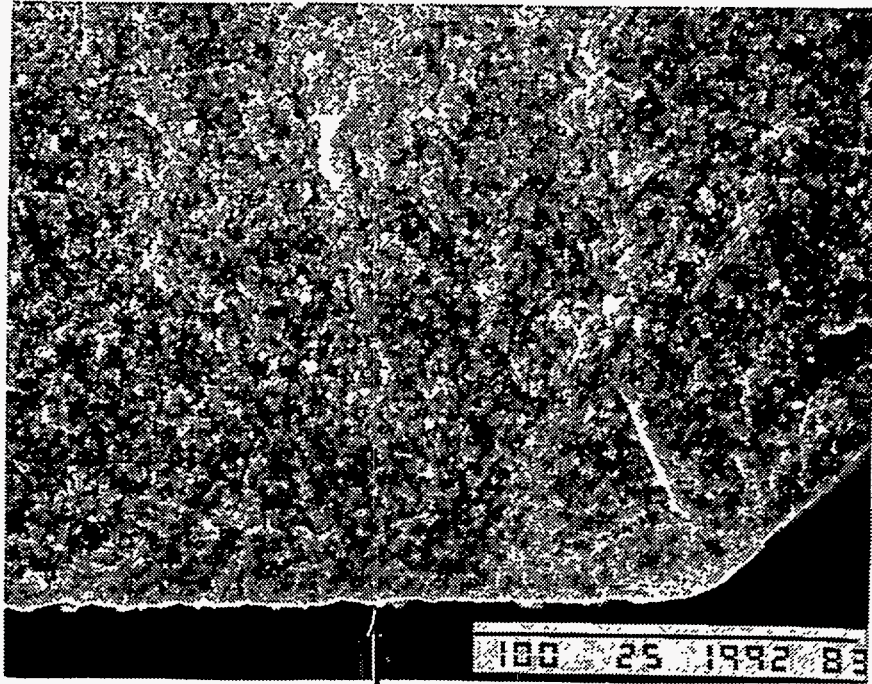
Specimen Number: 34.1838



Specimen Number: 34.1840

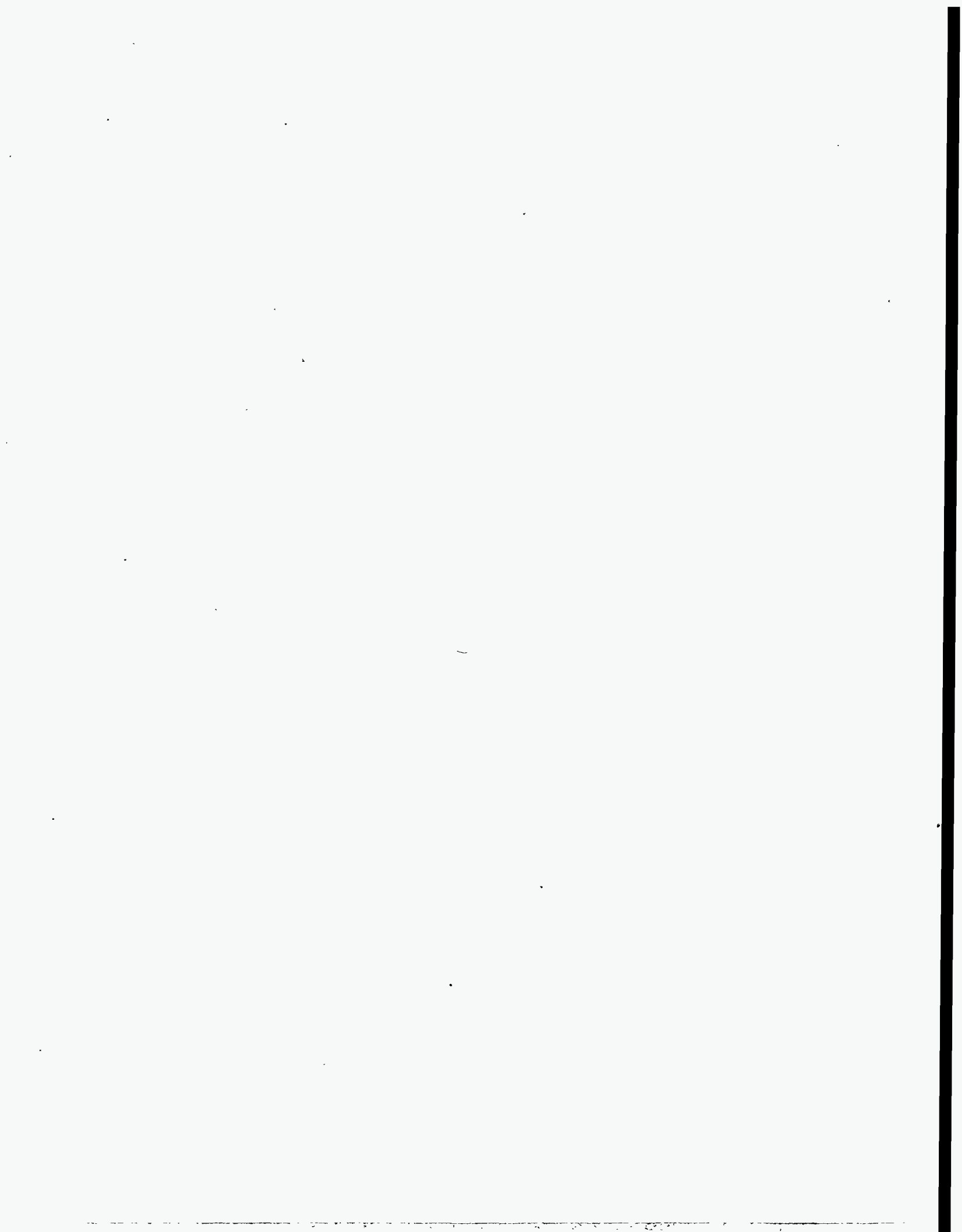


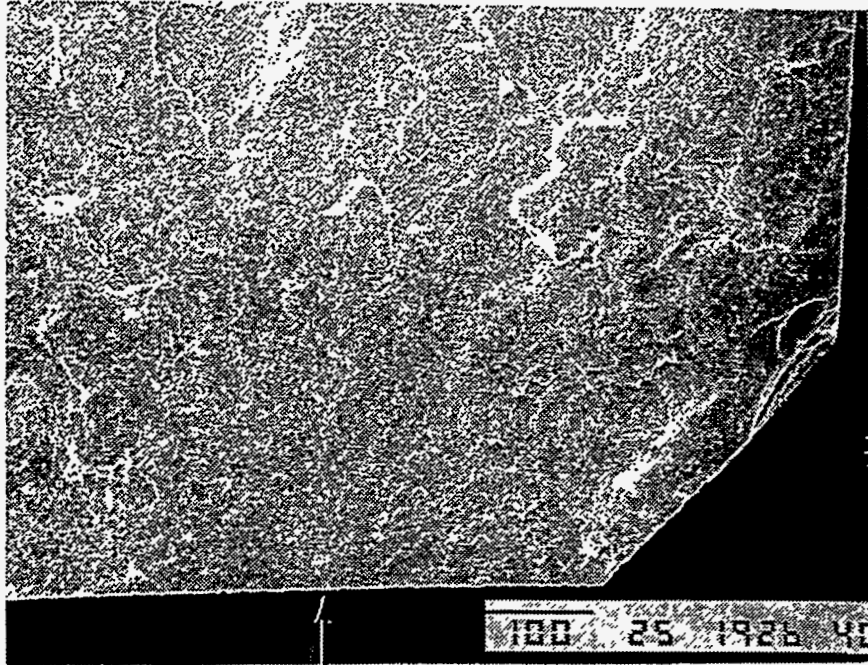
Specimen Number: 34.1841



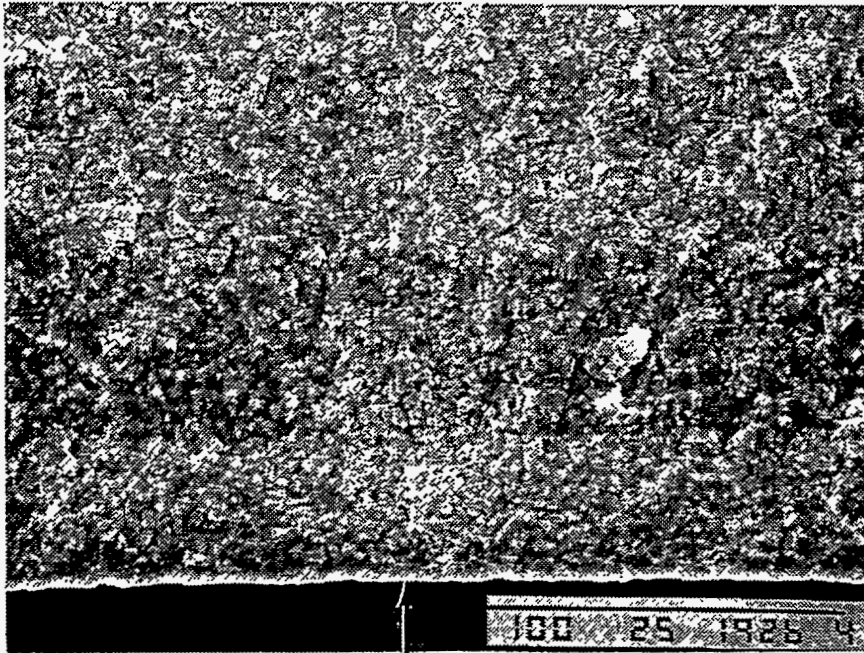
Specimen Number: 34.1842

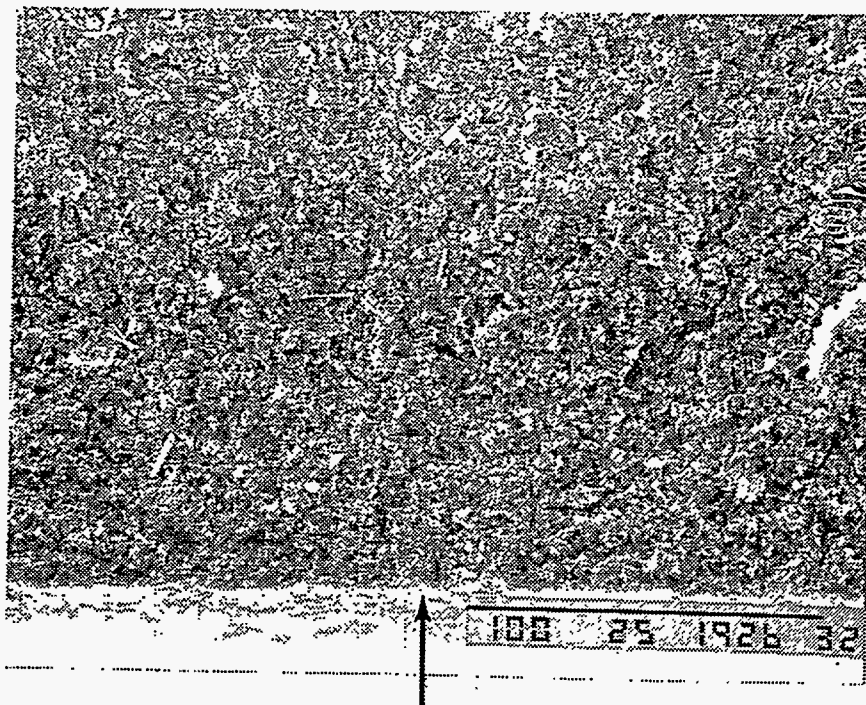
1200°C MOR SPECIMENS



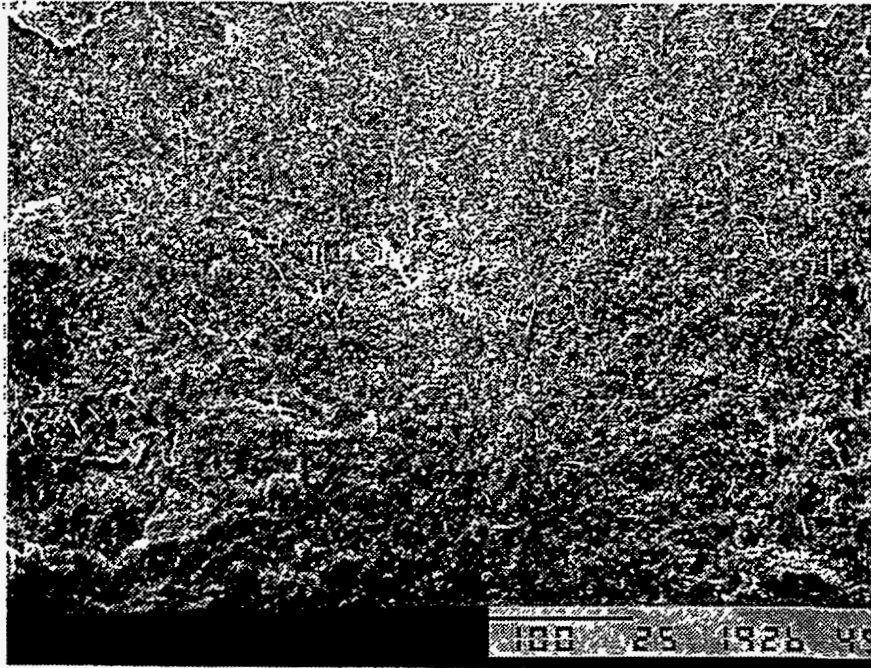


Specimen Number: 34.1457

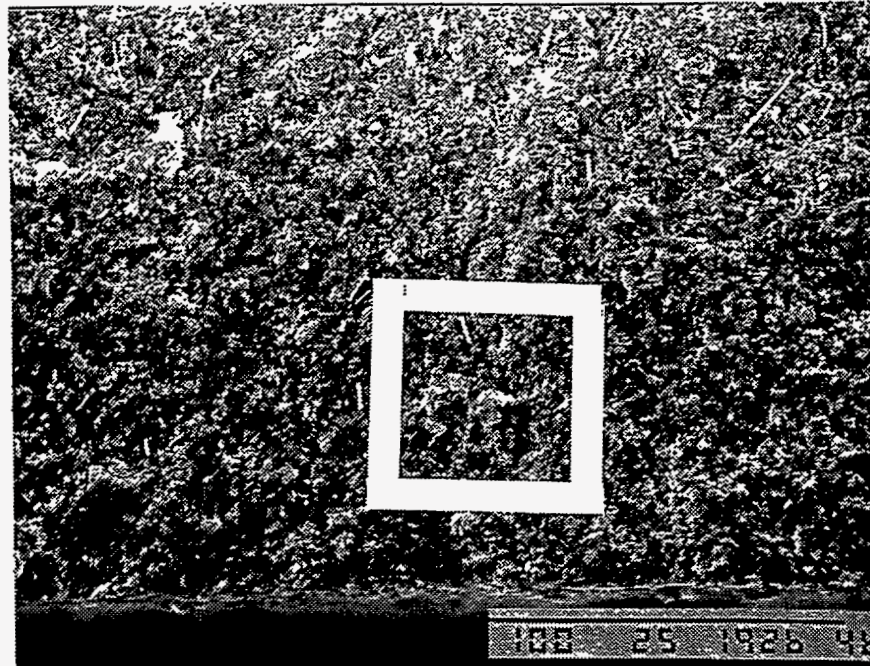


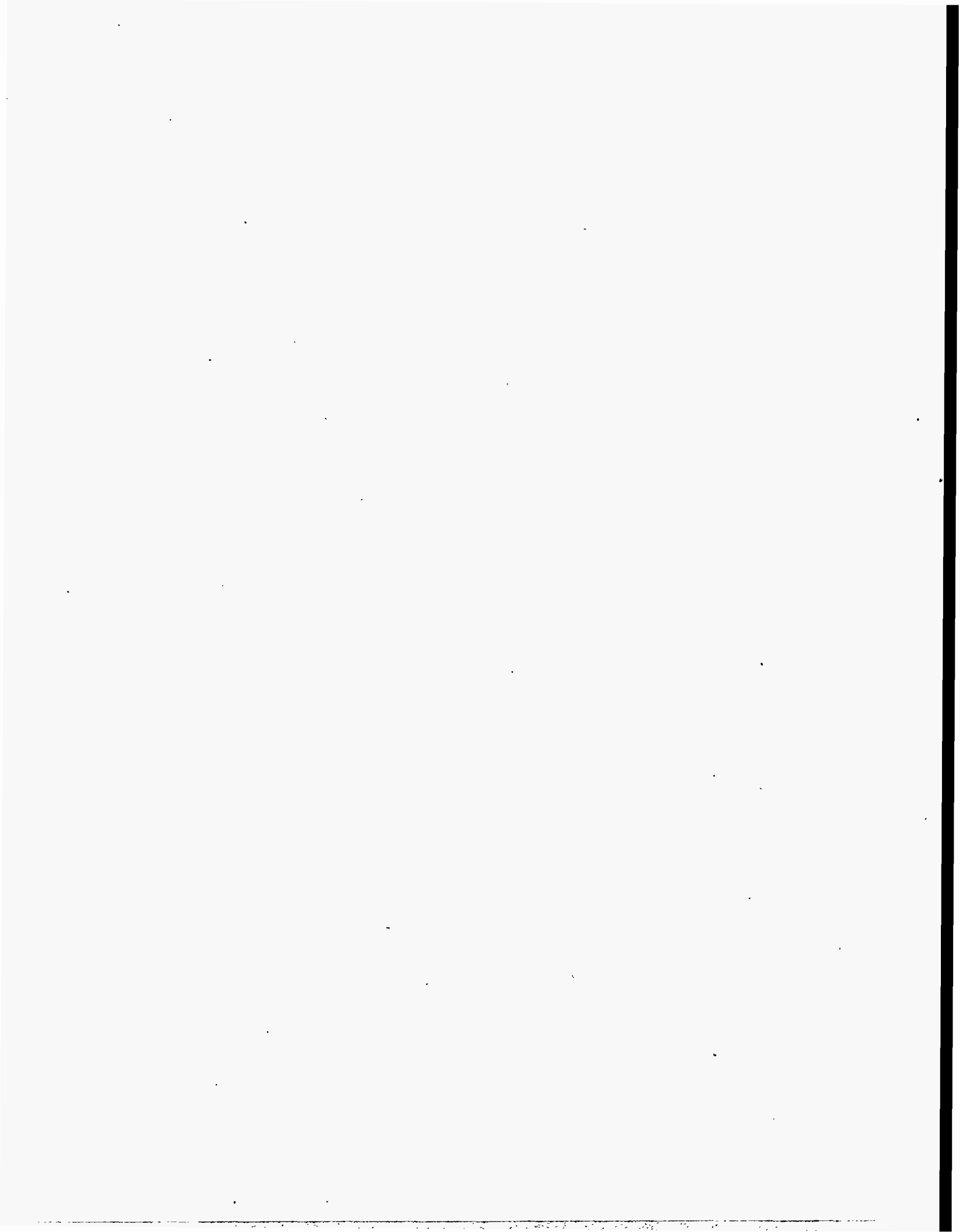


Specimen Number: 34.1458

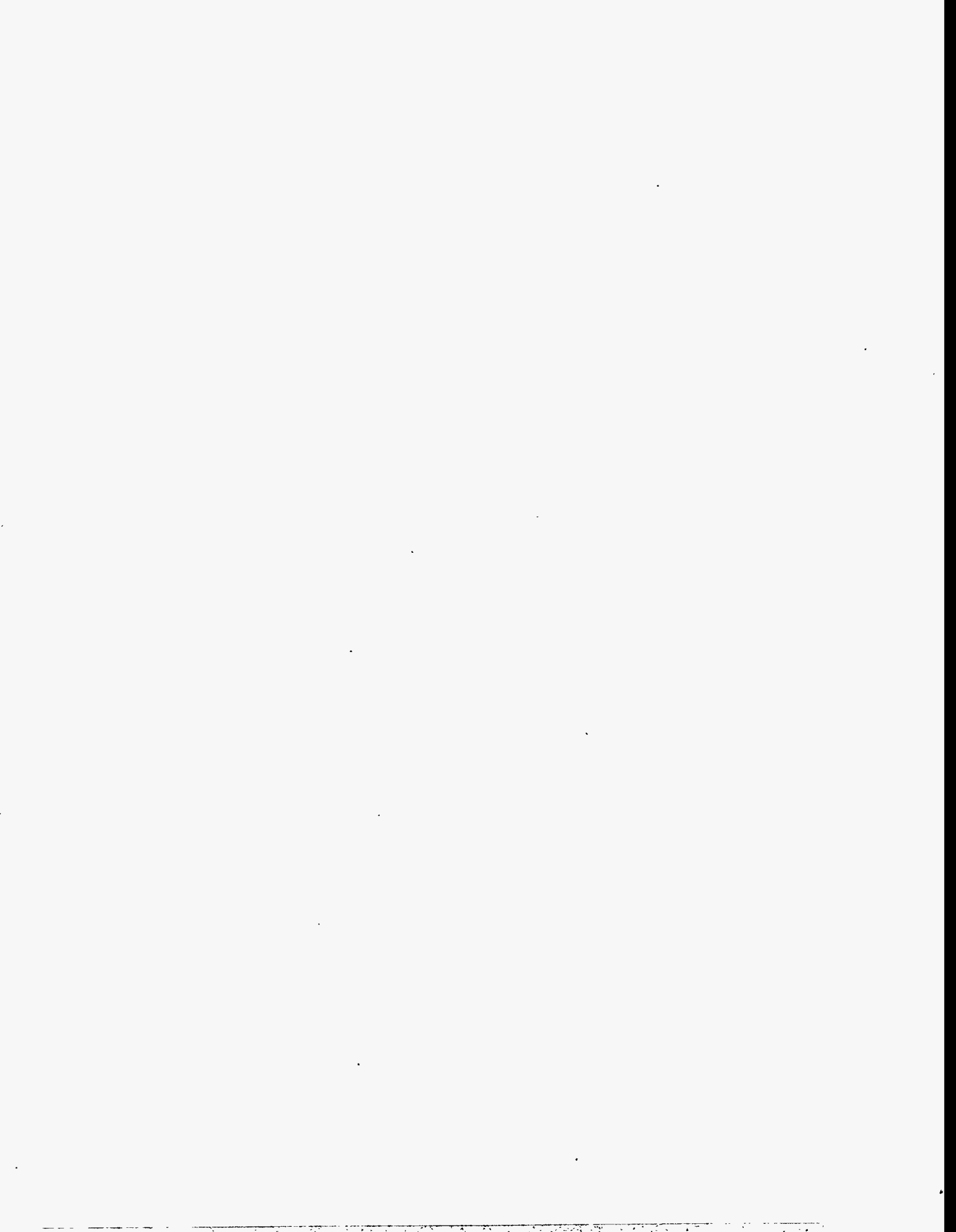


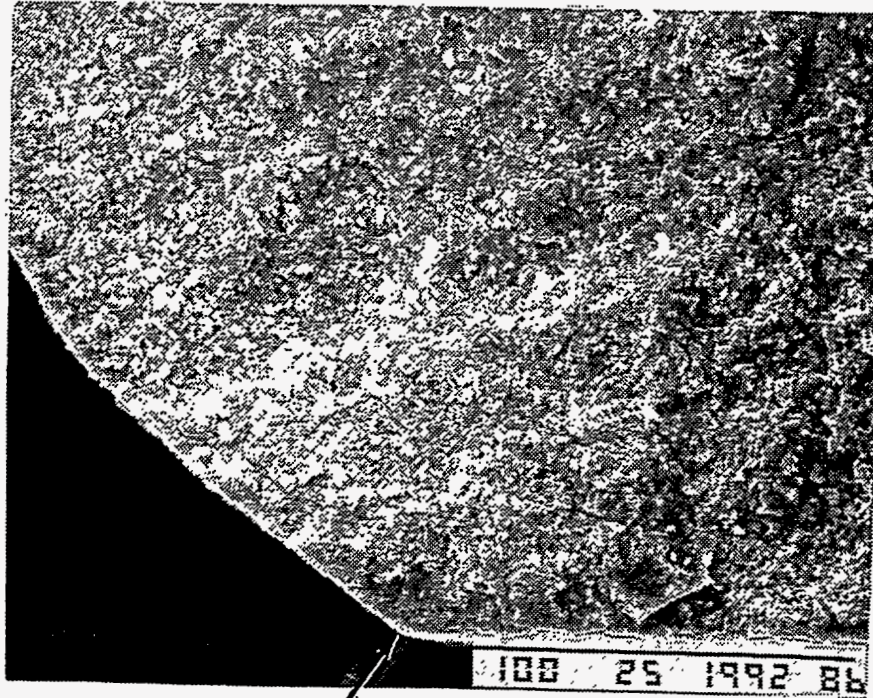
Specimen Number: 34.1459





1400°C MOR SPECIMENS





Specimen Number: 34.1800



Specimen Number: 34.1803

APPENDIX IV

**DYNAMIC FATIGUE TESTING OF MOR SPECIMENS IN AIR AND ARGON AT
THE OAK RIDGE NATIONAL LABORATORIES FROM 1000°C TO 1400°C**

IV-3

TABLE- : DYNAMIC FATIGUE BEHAVIOR OF MOR SPECIMENS CHARACTERIZED AT ORNL

SPECIMEN	TEMP.	ENVIRONMENT	STRESS RATE	STRENGTH		FAILURE
	DEG. C		MPa/SEC.	KSI	MPa	TIME, SEC
34.1856	25	AIR	37	75.13	518	14
34.1857	25	AIR	37	124.44	858	23
34.1858	25	AIR	37	78.03	538	15
			AVERAGE	92.53	638	17
			STD. DEV	22.59	156	4
34.1687	25	AIR	0.5	118.49	817	1634
34.1688	25	AIR	0.5	95.43	658	1316
34.1689	25	AIR	0.5	120.81	833	1666
			AVERAGE	111.58	769	1539
			STD. DEV	11.46	79	158
34.1878	25	AIR	0.001	74.26	512	512000
34.1879	25	AIR	0.001	71.36	492	492000
34.1880	25	AIR	0.001	55.69	384	384000
			AVERAGE	67.10	463	462667
			STD. DEV	8.15	56	56222
34.1661	1000	AIR	37	87.89	606	16
34.1662	1000	AIR	37	89.92	620	17
34.1663	1000	AIR	37	84.55	583	16
			AVERAGE	87.45	603	16
			STD. DEV	2.21	15	0
34.1672	1000	AIR	0.5	79.62	549	1098
34.1673	1000	AIR	0.5	71.79	495	990
34.1674	1000	AIR	0.5	71.21	491	982
			AVERAGE	74.21	512	1023
			STD. DEV	3.84	26	53
34.1659	1000	AIR	0.001	77.88	537	537000
34.1660	1000	AIR	0.001	77.01	531	531000
			AVERAGE	77.45	534	534000
			STD. DEV	0.44	3	3000

IV-4

TABLE- : DYNAMIC FATIGUE BEHAVIOR OF MOR SPECIMENS CHARACTERIZED AT ORNL

SPECIMEN	TEMP.	ENVIRONMENT	STRESS RATE	STRENGTH		FAILURE
	DEG. C		MPa/SEC.	KSI	MPa	TIME, SEC
34.1853	1200	AIR	37	84.70	584	16
34.1854	1200	AIR	37	93.84	647	17
34.1855	1200	AIR	37	69.33	478	13
			AVERAGE	82.62	570	15
			STD. DEV	10.11	70	2
34.1691	1200	AIR	0.5	68.31	471	942
34.1692	1200	AIR	0.5	56.56	390	780
34.1693	1200	AIR	0.5	54.82	378	756
			AVERAGE	59.90	413	826
			STD. DEV	5.99	41	83
34.1850	1200	AIR	0.001	54.24	374	374000
34.1851	1200	AIR	0.001	50.04	345	345000
34.1852	1200	AIR	0.001	54.97	379	379000
			AVERAGE	53.08	366	366000
			STD. DEV	2.17	15	14989
34.1871	1400	AIR	37	74.84	516	14
34.1872	1400	AIR	37	59.32	409	11
34.1873	1400	AIR	37	67.88	468	13
			AVERAGE	67.34	464	13
			STD. DEV	6.35	44	1
34.1666	1400	AIR	0.5	34.66	239	478
34.1667	1400	AIR	0.5	44.67	308	616
34.1668	1400	AIR	0.5	32.78	226	452
			AVERAGE	37.37	258	515
			STD. DEV	5.22	36	72
34.1874	1400	AIR	0.001	30.31	209	209000
34.1875	1400	AIR	0.001	29.30	202	202000
34.1876	1400	AIR	0.001	25.67	177	177000
			AVERAGE	28.43	196	196000
			STD. DEV	1.99	14	13736

IV-5

TABLE- : DYNAMIC FATIGUE BEHAVIOR OF MOR SPECIMENS CHARACTERIZED AT ORNL

SPECIMEN	TEMP. DEG. C	ENVIRONMENT	STRESS RATE MPa/SEC.	STRENGTH		FAILURE TIME, SEC
				KSI	MPa	
34.2079	1000	ARGON	37	108.34	747	20
34.2080	1000	ARGON	37	116.46	803	22
			AVERAGE	112	775	21
			STD. DEV	4.06	28	1
34.2076	1000	ARGON	0.5	79.62	549	1098
34.2078	1000	ARGON	0.5	71.79	495	990
			AVERAGE	76	522	1044
			STD. DEV	3.92	27	54
34.1696	1000	ARGON	0.001	94.13	649	649000
34.1697	1000	ARGON	0.001	99.20	684	684000
34.1698	1000	ARGON	0.001	115.74	798	
			AVERAGE	96.66	667	666500
			STD. DEV	2.54	18	17500
34.1669	1200	ARGON	37	89.63	618	17
34.1670	1200	ARGON	37	85.86	592	16
34.1671	1200	ARGON	37	77.88	537	15
			AVERAGE	84.46	582	16
			STD. DEV	4.90	34	1
34.1702	1200	ARGON	0.5	88.18	608	1216
34.1703	1200	ARGON	0.5	64.97	448	896
34.1704	1200	ARGON	0.5	65.99	455	910
			AVERAGE	73.05	504	1007
			STD. DEV	10.71	74	148
34.1694	1200	ARGON	0.001	87.89	606	606000
34.1690	1200	ARGON	0.001	97.17	670	670000
34.1695	1200	ARGON	0.001	100.07	690	690000
			AVERAGE	95.04	655	655333
			STD. DEV	5.20	36	35827
34.1812	1400	ARGON	37	98.62	680	18
34.1664	1400	ARGON	37	94.56	652	18
34.1665	1400	ARGON	37	79.62	549	15
			AVERAGE	90.94	627	17
			STD. DEV	8.17	56	2
34.1699	1400	ARGON	0.5	73.39	506	1012
34.1700	1400	ARGON	0.5	76.87	530	1060
34.1701	1400	ARGON	0.5	84.84	585	1170
			AVERAGE	78.37	540	1081
			STD. DEV	4.80	33	66
34.1870	1400	ARGON	0.001	53.37	368	368000
34.1675	1400	ARGON	0.001	52.94	365	365000
34.1676	1400	ARGON	0.001	55.40	382	382000
			AVERAGE	53.90	372	371667
			STD. DEV	1.07	7	7409

APPENDIX V

**DYNAMIC FATIGUE TESTING OF BUTTON-HEAD TENSILE SPECIMENS IN AIR
AT SOUTHERN RESEARCH INSTITUTE**

Dynamic fatigue behavior of button-head tensile specimens.

Specimen number	Temperature— °C	Stress rate— MPa/sec	Strength		Modulus— GPa	Strain- to-failure— in./in.	Failure time— sec	Failure origin	Failure location from center of gage— mm	
			ksi	MPa					+	-
493B	1000	69	45.15	311.27	329.4	0.0010	5	II		29.21
118B	1000	69	65.55	451.97	293.1	0.0016	7	SF	7.62	-
121B	1000	69	65.55	451.96	288.8	0.0016	7	SF		27.18
52A	1000	69	43.49	299.86	300.4	0.0010	4	SI	9.40	
05A	1000	69	67.00	461.94	267.5	0.0019	7	SF		26.67
51A	1000	6.9	41.69	287.45	333.9	0.0009	42	SF		15.24
54A	1000	6.9	37.44	258.15	331.3	0.0008	37	SF	2.54	
60A	1000	0.115	46.01	317.24	283.7	0.0012	2759	SF		28.45
568B	1000	0.115	38.20	263.39	292.2	0.0009	2290	SF		3.81
655B	1100	69	45.16	311.38	301.1	0.0010	5	SI		13.21
53A	1100	69	45.38	312.90	248.4	0.0013	5	SF	31.24	
482B	1100	69	46.25	318.89	304.0	0.0010	5	SF		17.78
653B	1100	69	43.35	298.90	259.0	0.0012	4	IP		25.40
454B	1100	69	49.22	339.37			5	IP		
67A	1100	6.9	40.72	280.76	-	-	41	Failed at two locations within gage		
569A	1100	6.9	54.71	377.23	275.5	0.0014	55	II	3.05	
547A	1100	0.115	37.24	256.77	212.0	0.0012	2233	See note 1		
549B	1100	0.115	44.15	304.41	313.3	0.0009	2647	See note 1		
556A	1100	0.115	42.64	294.00	297.9	0.0010	2557	II		12.70
484B	1200	69	45.65	314.76	306.1	0.0010	5	SF	21.59	
520B	1200	69	44.94	309.86	292.9	0.0011	4	SF		25.91
520A	1200	69	45.35	312.69	300.0	0.0011	5	SF		24.13
490A	1200	69	44.85	309.24	298.8	0.0010	4	SF		23.62
518B	1200	69	45.34	312.62	295.7	0.0011	5	Failed at two locations within gage		
558A	1200	6.9	38.69	266.77	265.2	0.0010	39	See note 1		
558B	1200	6.9	36.50	251.67	252.3	0.0010	36	See note 1		
554B	1200	0.115	34.33	236.71	264.4	0.0009	2058	See note 1		
546B	1200	0.115	46.36	319.65	304.3	0.0012	2780	II		17.02
564B	1200	0.115	59.13	407.70	306.0	0.0012	3545	Failed at two locations within gage		
521A	1200	0.115	33.20	228.91	253.3	0.0006	1991	IF		
534A	1200	0.115	38.17	263.18	329.4	0.0008	2289	SF		25.40

Specimen number	Temperature— °C	Stress rate— MPa/sec	Strength		Modulus— GPa	Strain- to-failure— in./in.	Failure time— sec	Failure origin	Failure location from center of gage— mm	
			ksi	MPa					+	-
192A	1300	69	55.62	383.50	299.7	0.0013	6	II	13.97	
184B	1300	69	55.12	380.05	305.7	0.0013	6	SF		27.94
332A	1300	69	53.83	371.16	306.2	0.0012	5	II	5.33	
54B	1300	69	58.10	400.60	280.6	0.0014	6	Failed at two locations within gage		
110A	1300	69	52.69	363.30	304.3	0.0012	5	II		
553A	1300	6.9	49.01	337.92	325.6	0.0011	49	II		13.21
549A	1300	6.9	44.04	303.66	329.2	0.0009	44	SF		29.46
565A	1300	0.115	48.80	336.48	258.0	0.0016	2926	SF		3.05
574A	1300	0.115	34.84	240.22	241.3	0.0012	2089	See note 1		16.51
575A	1300	0.115	36.84	254.01	304.4	0.0012	2209	II	17.78	
662A	1400	69	43.83	302.21	321.0	0.0010	4	II	5.08	
661A	1400	69	43.96	303.10	316.0	0.0010	4	II	12.19	
664A	1400	69	43.70	301.31	319.2	0.0010	4	II	10.92	
329B	1400	69	42.97	296.28	319.0	0.0010	4	SI		
334A	1400	69	44.23	304.97	276.6	0.0012	4	II		20.83
545A	1400	6.9	38.96	268.63	309.5	0.0012	39	SF	1.27	
548A	1400	6.9	32.04	220.92	290.6	0.0010	32	See note 1		2.54
526A	1400	0.115	22.09	152.31	183.4	0.0015	1324	See note 1	2.54	
571A	1400	0.115	22.62	155.96	131.8	0.0017	1356	SF	1.27	
564A	1400	0.115	26.08	179.82	157.3	0.0021	1564	SF	5.08	
81C	1400	0.115	26.86	185.20	-	-	1610	SF	8.89	

+: Towards top of the loading rod

SF - Surface machining flaw

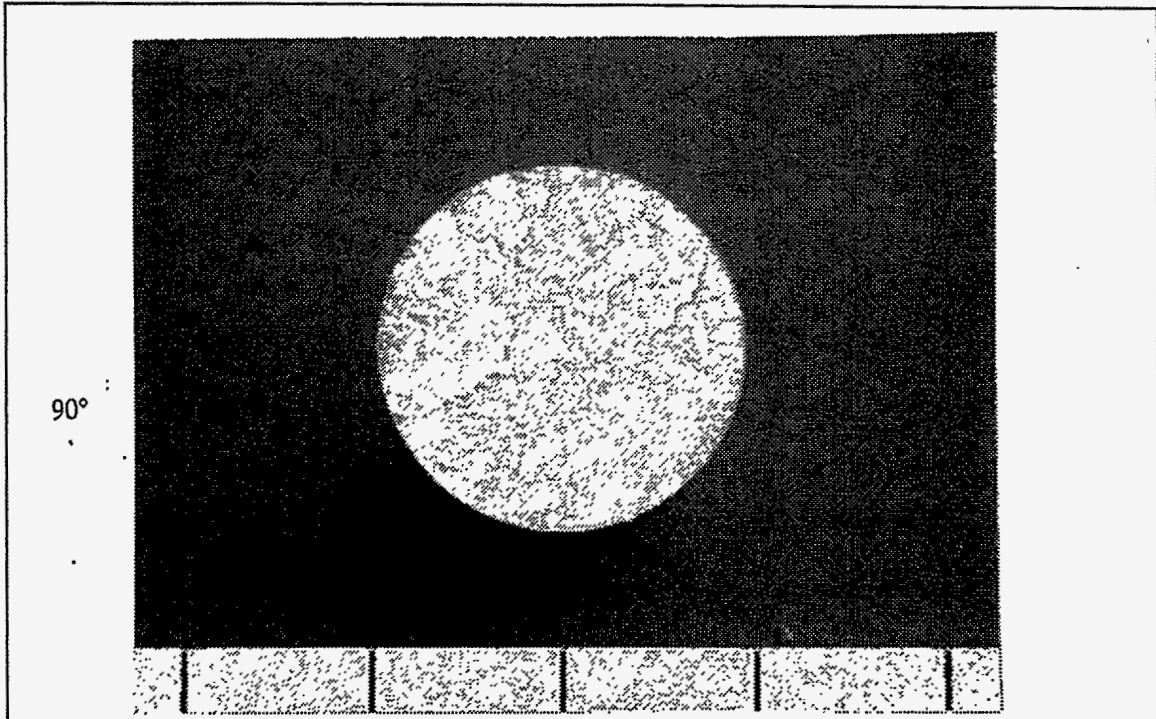
-: Towards bottom of the loading rod

SI - Surface inclusion

IP - Internal pore

II - Internal inclusion

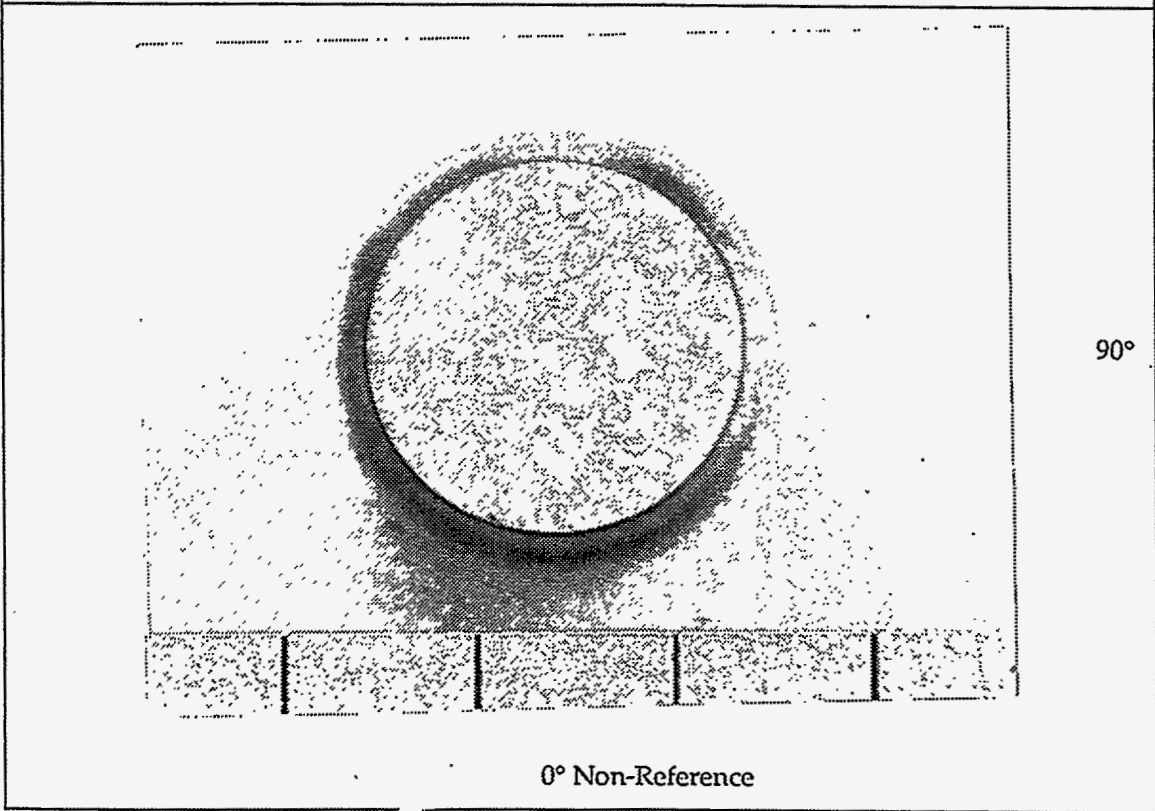
Note 1: Specimen packing opened up in transit from Southern Research Institute to Allison. This caused mix up in specimens and difficulty in matching broken ends of specimens to identify failure origin. In some cases it was possible to identify flaw location.



90°

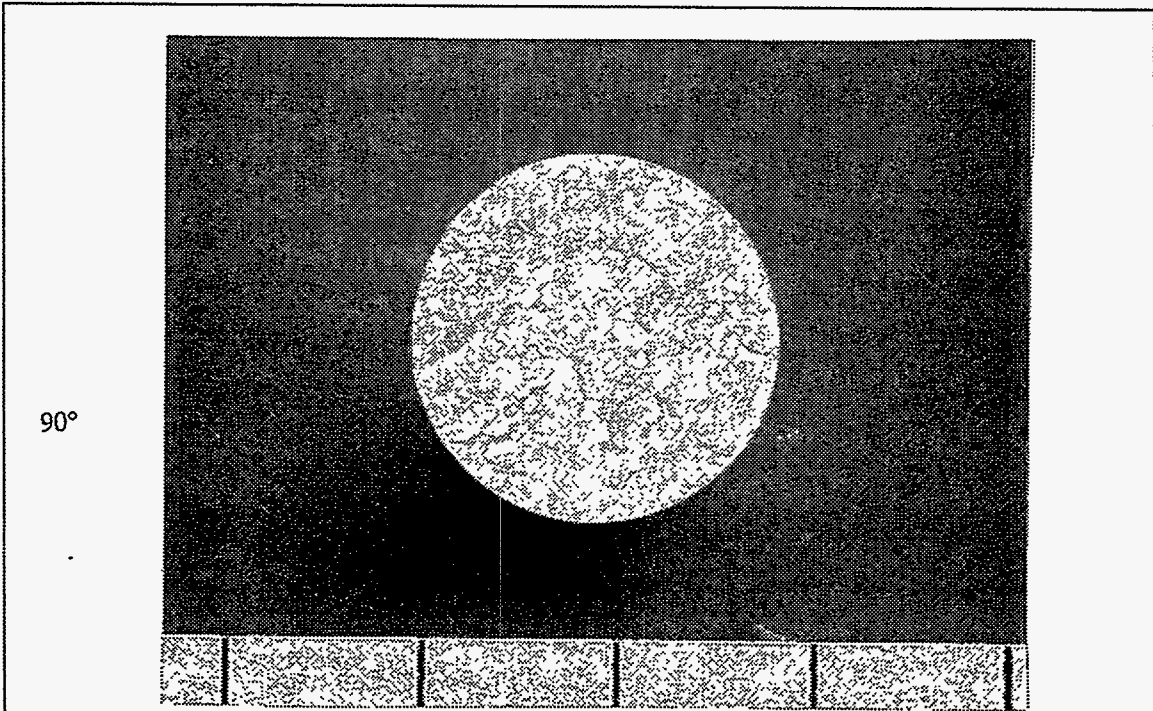
Specimen Number: 547A

0° Reference End



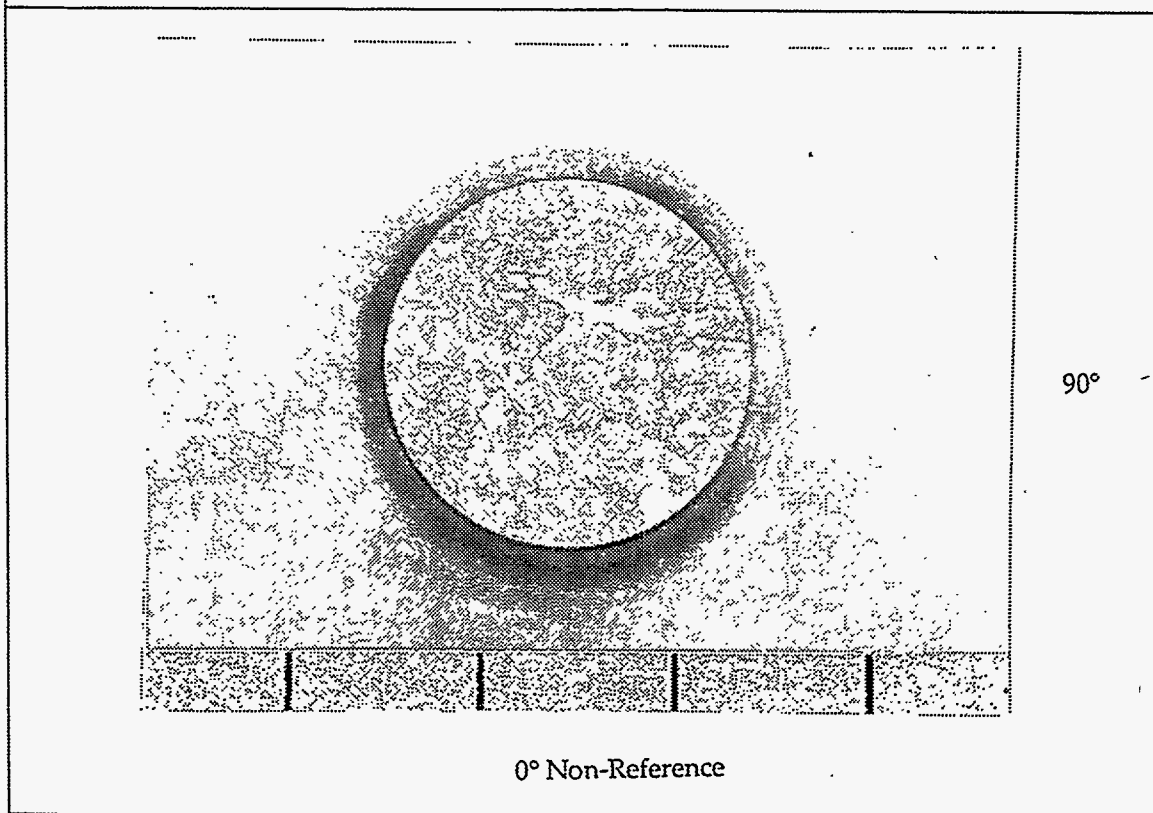
90°

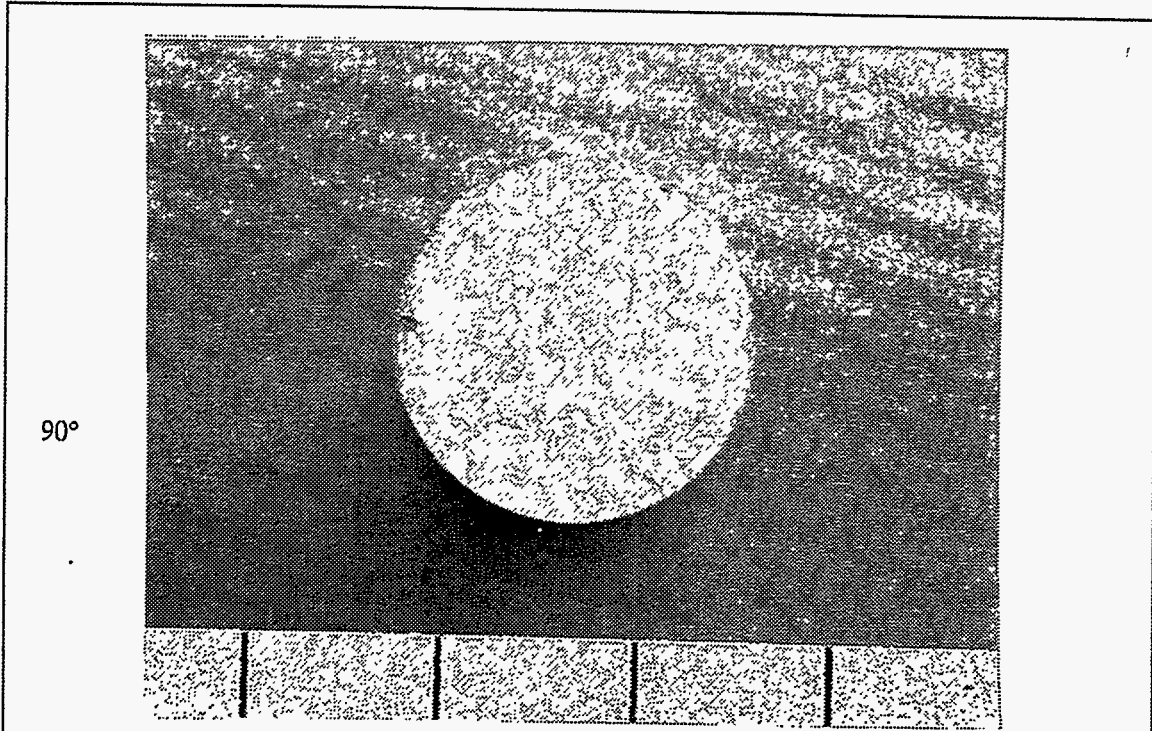
0° Non-Reference



Specimen Number: 549B

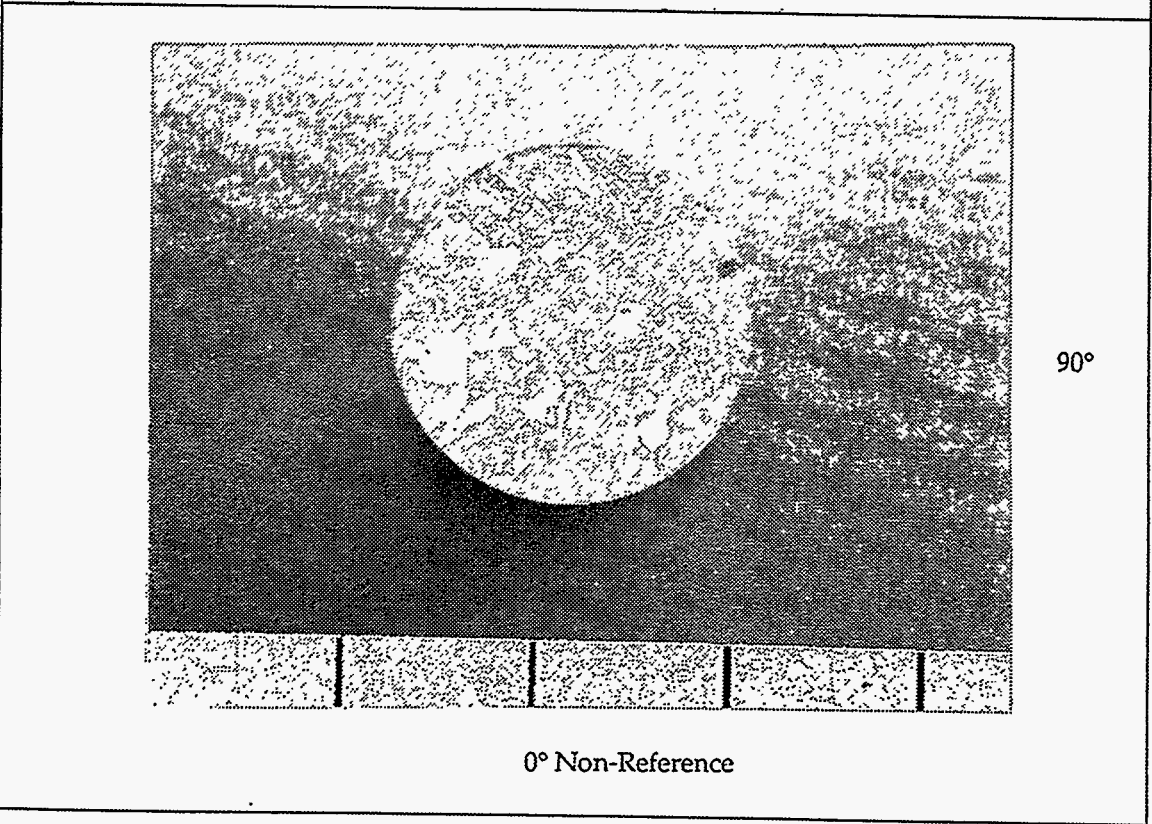
0° Reference End



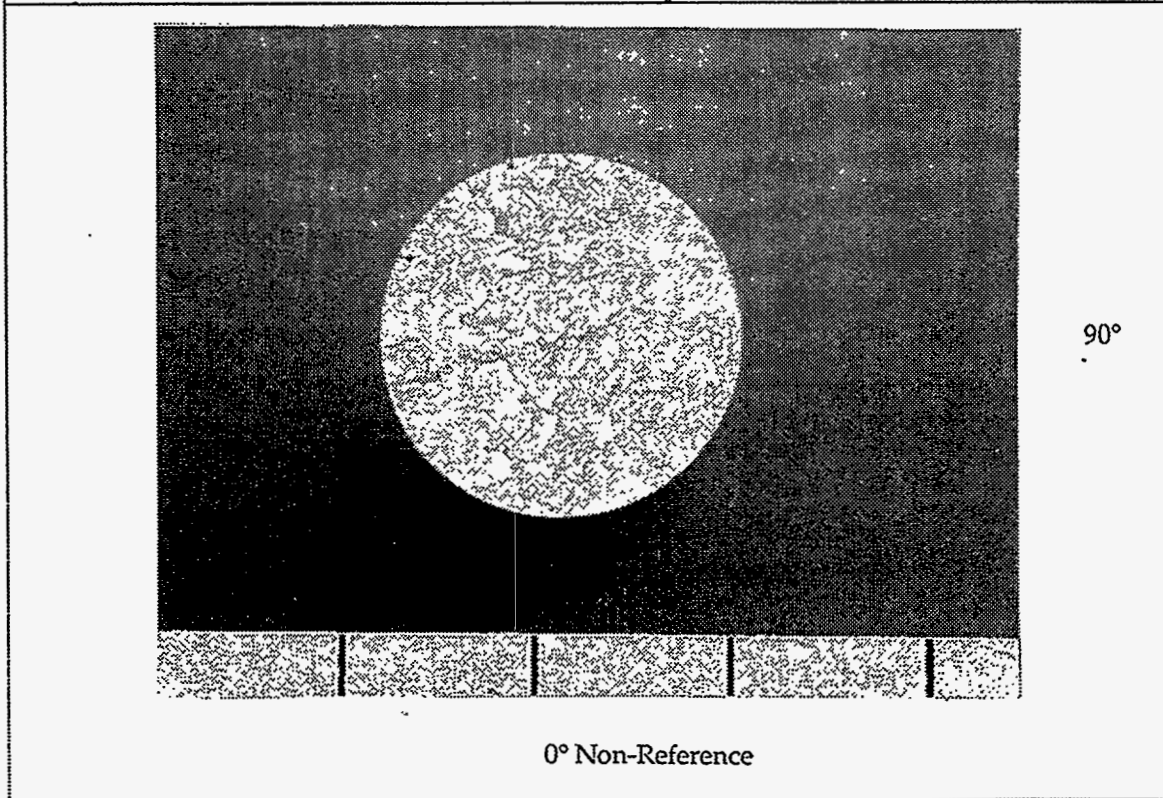
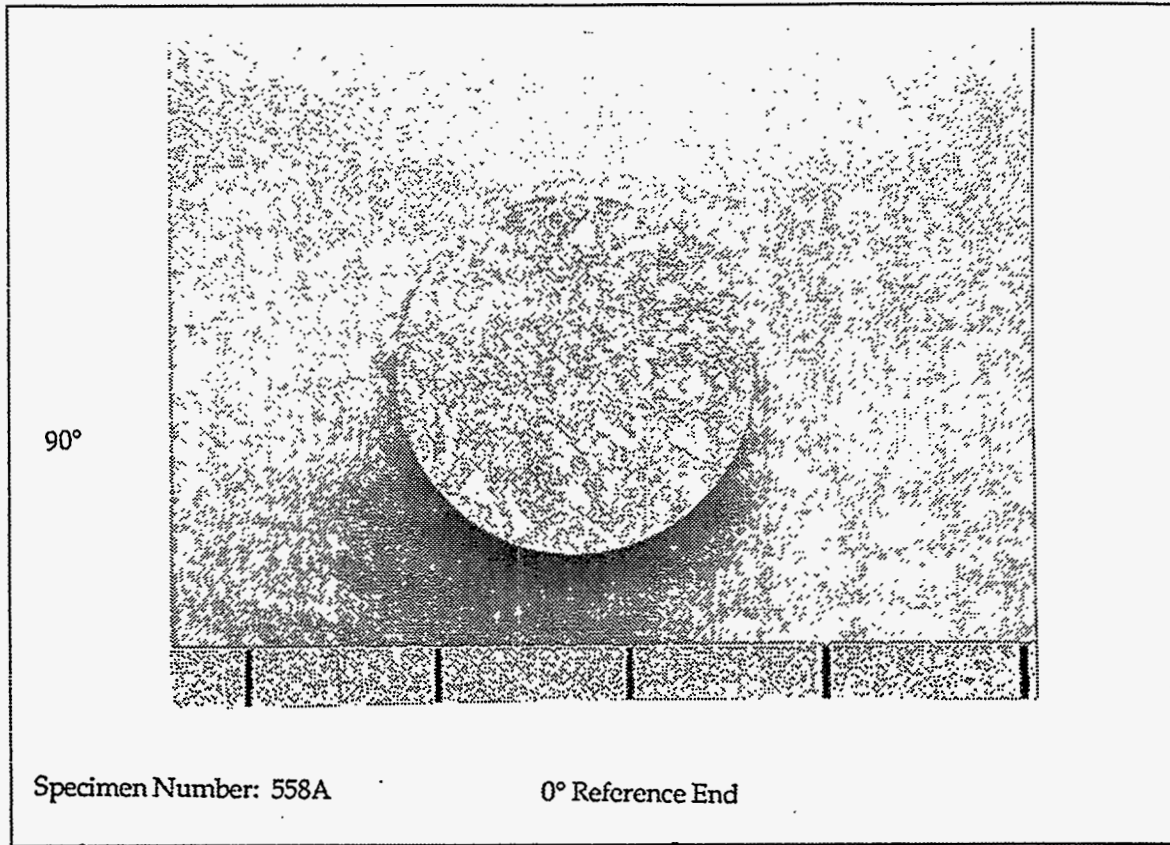


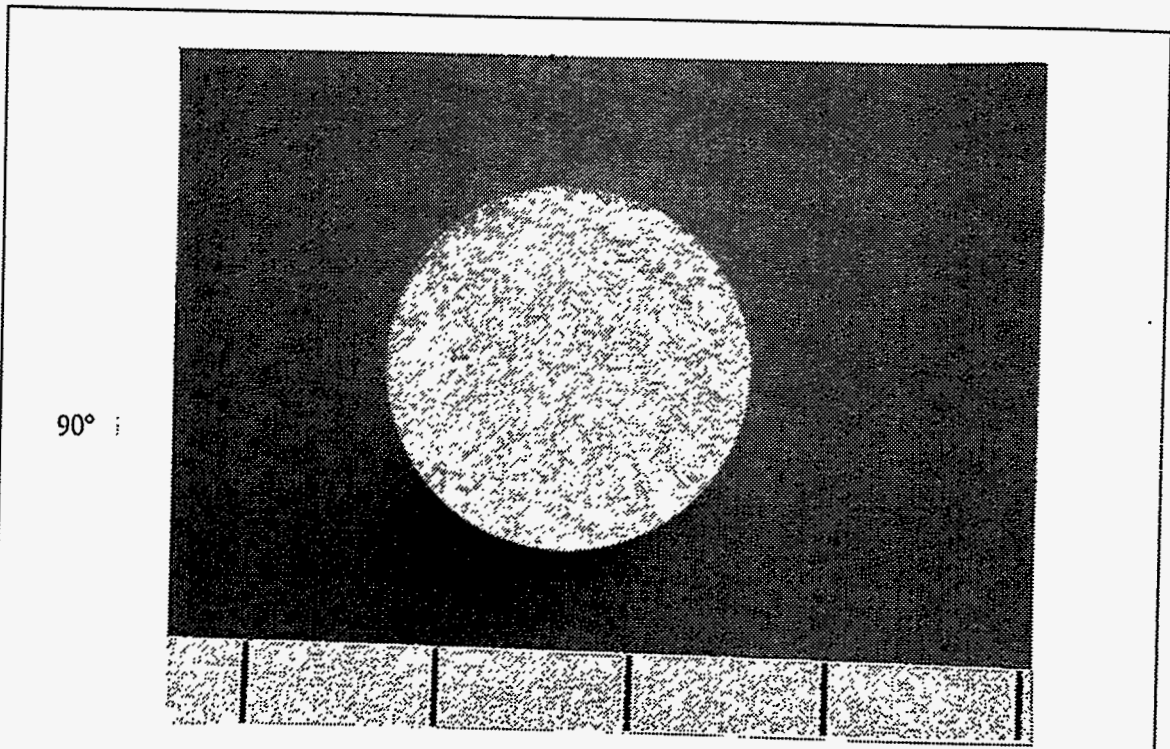
Specimen Number: 556A

0° Reference End



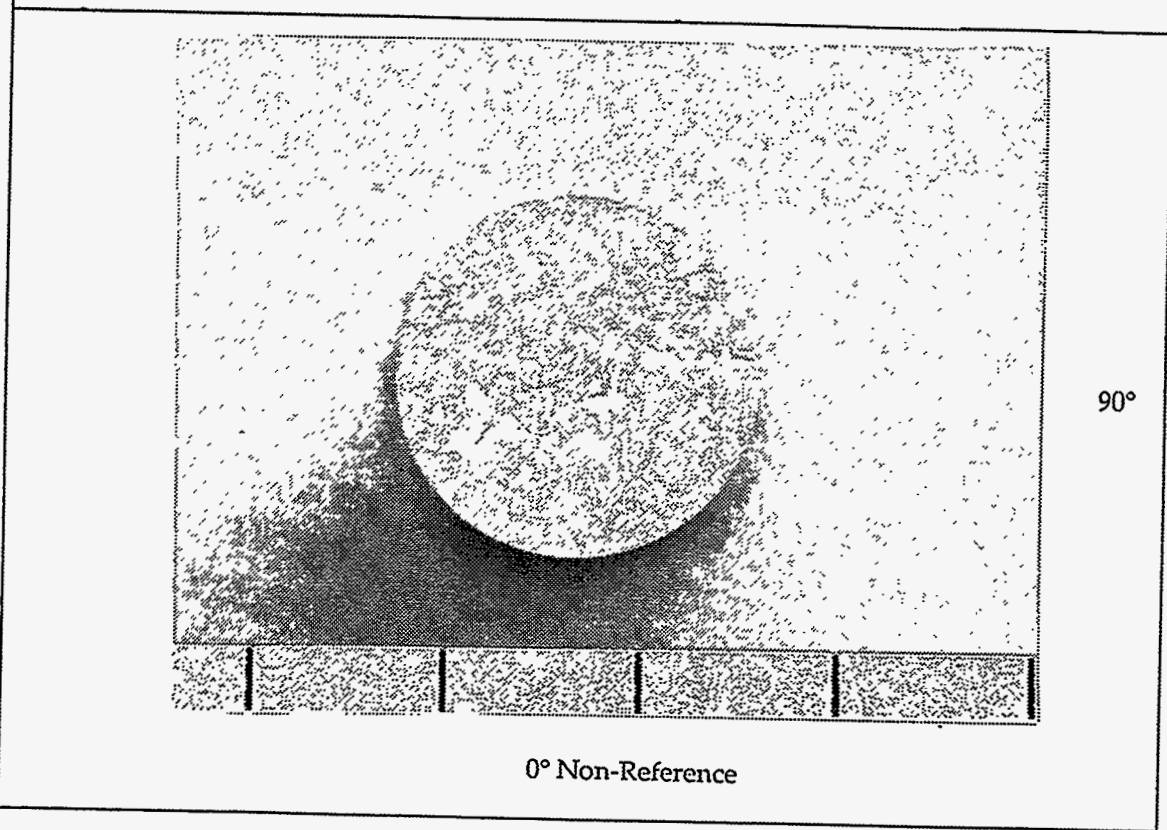
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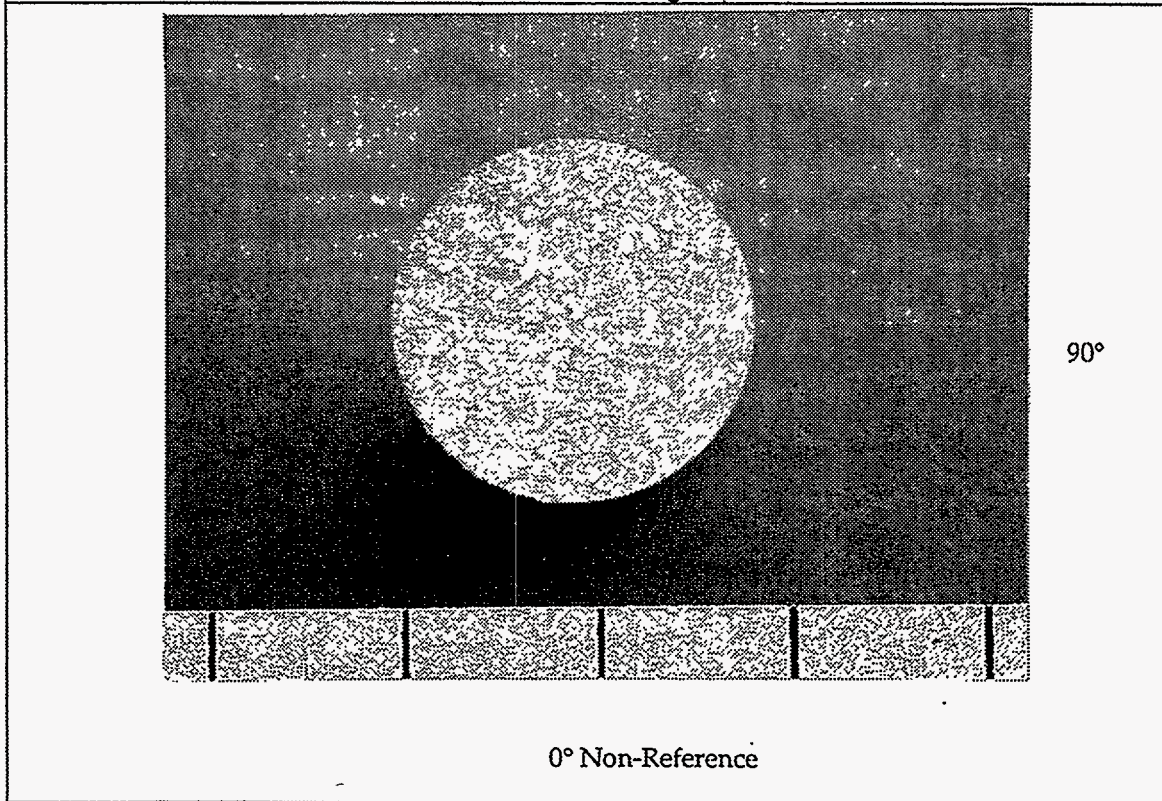
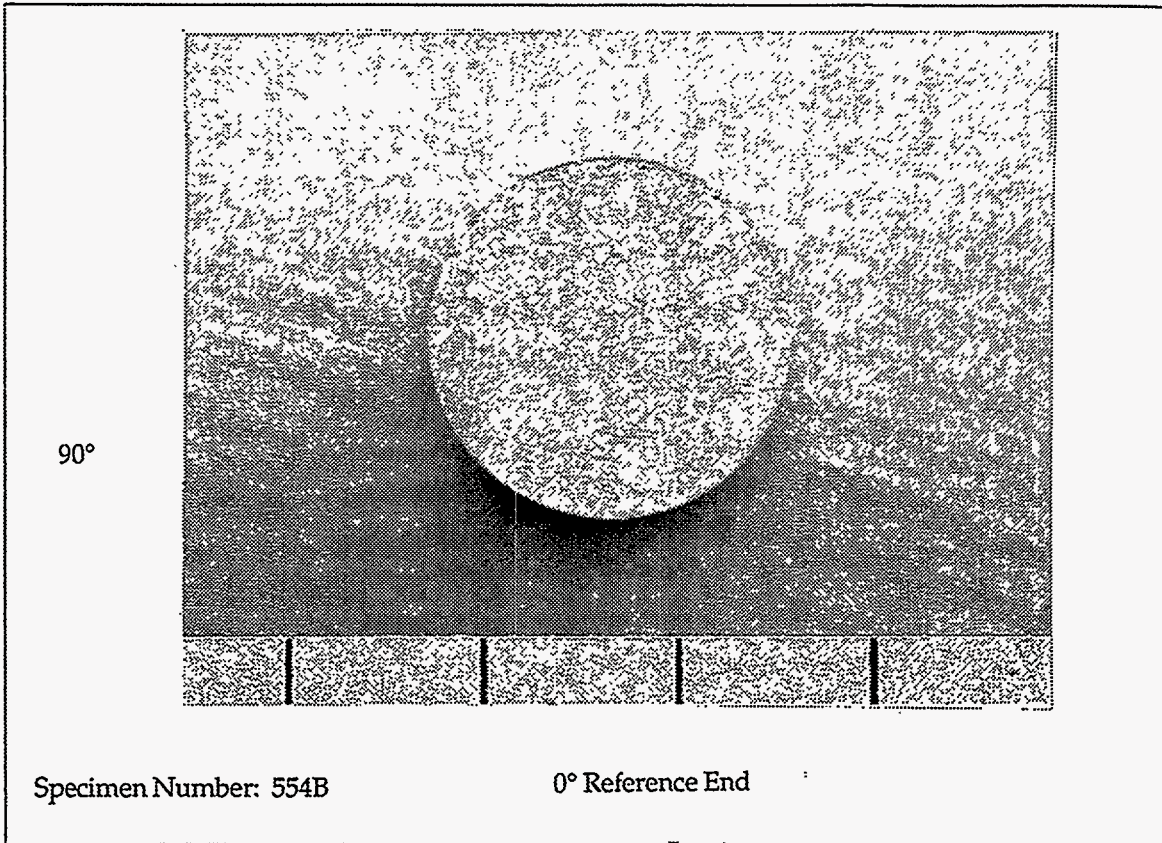


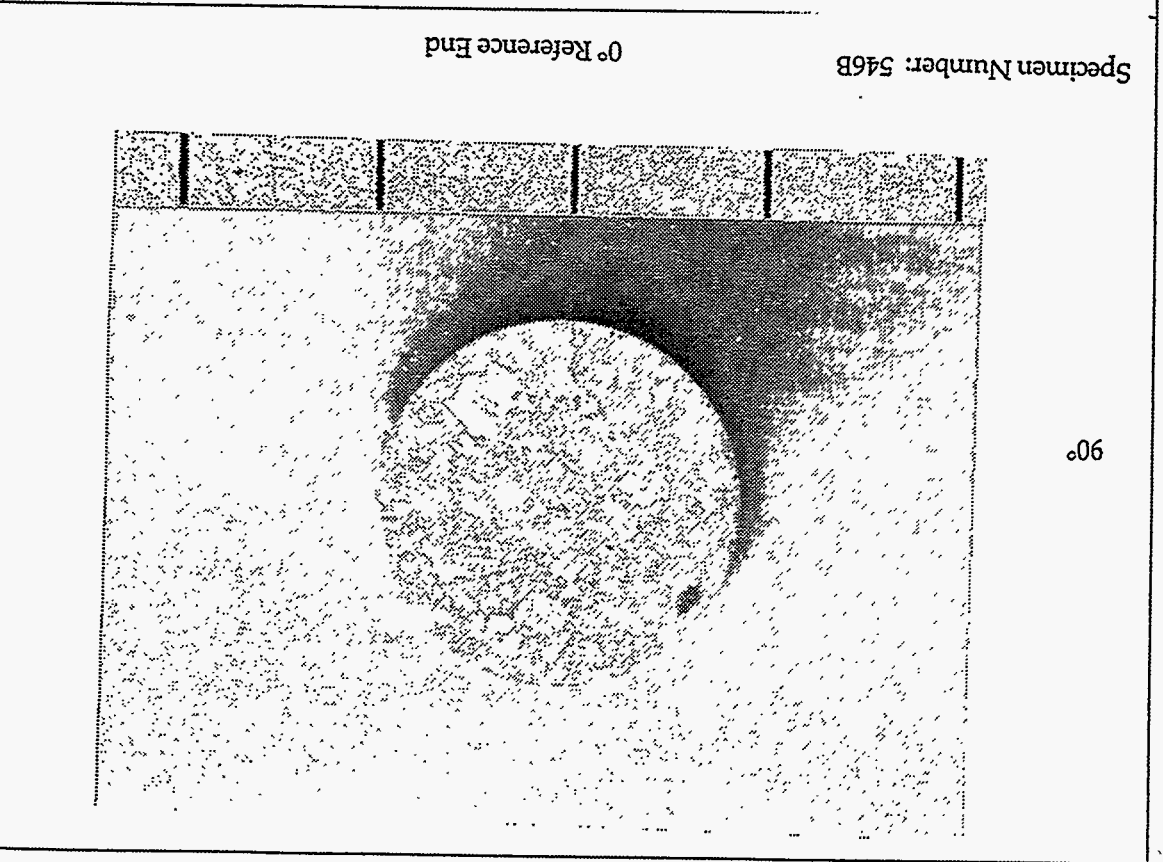
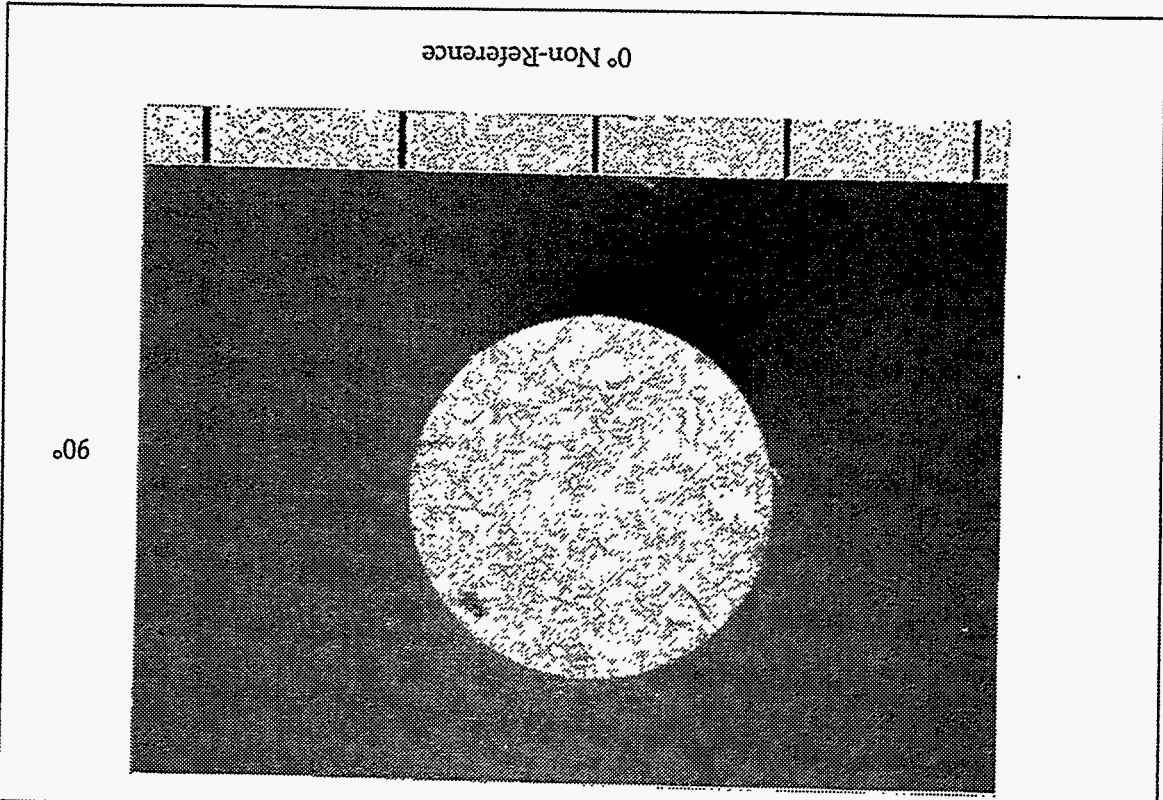
Specimen Number: 558B

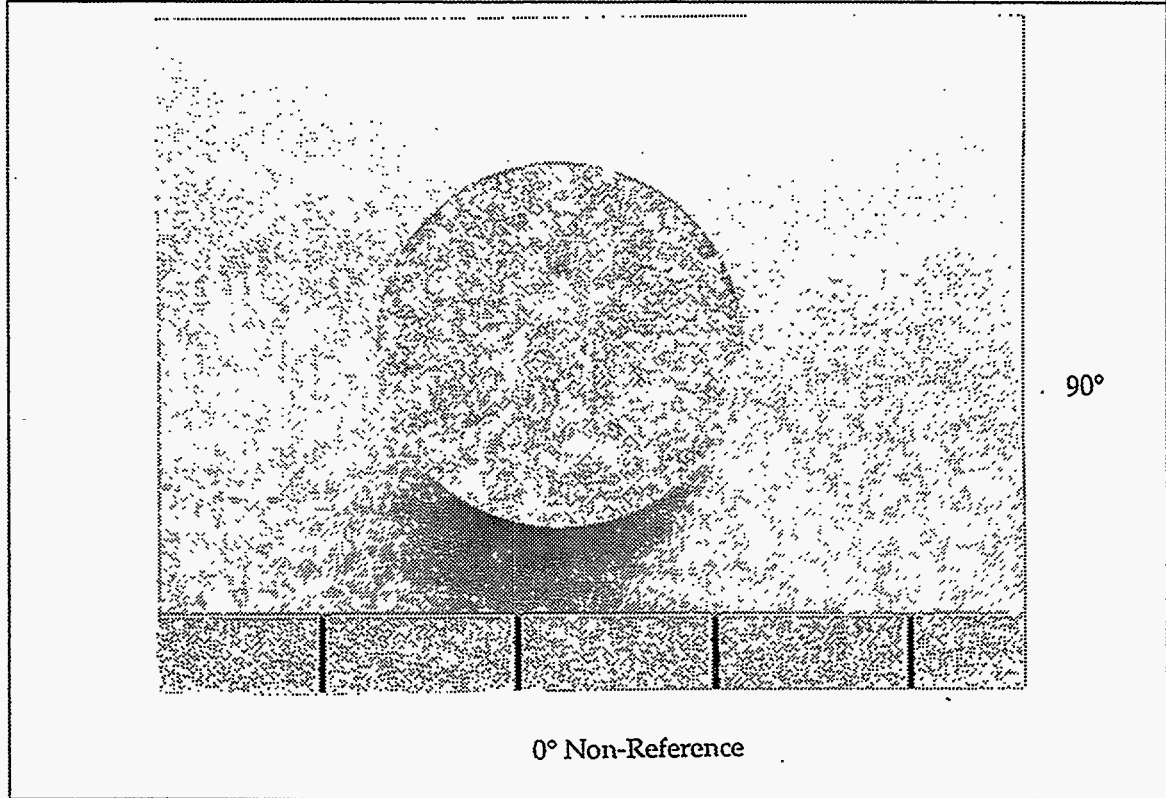
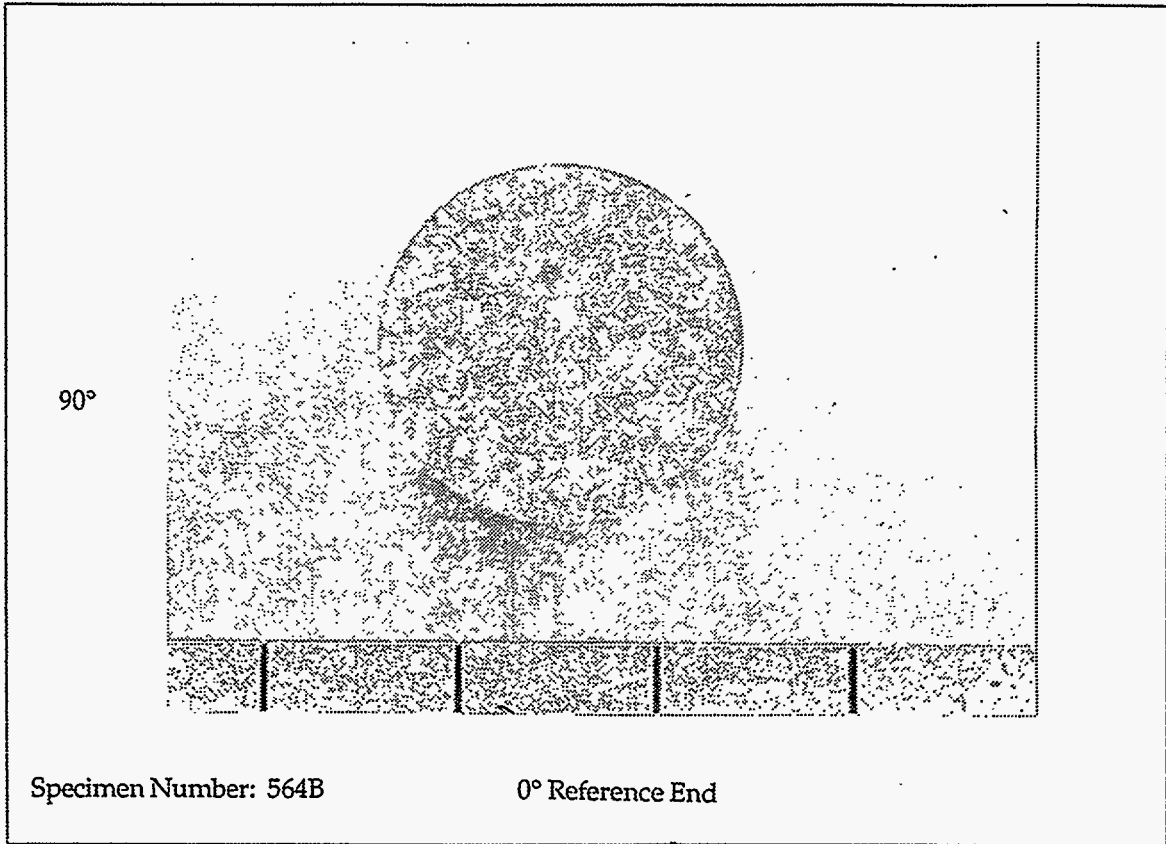
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0° Non-Reference

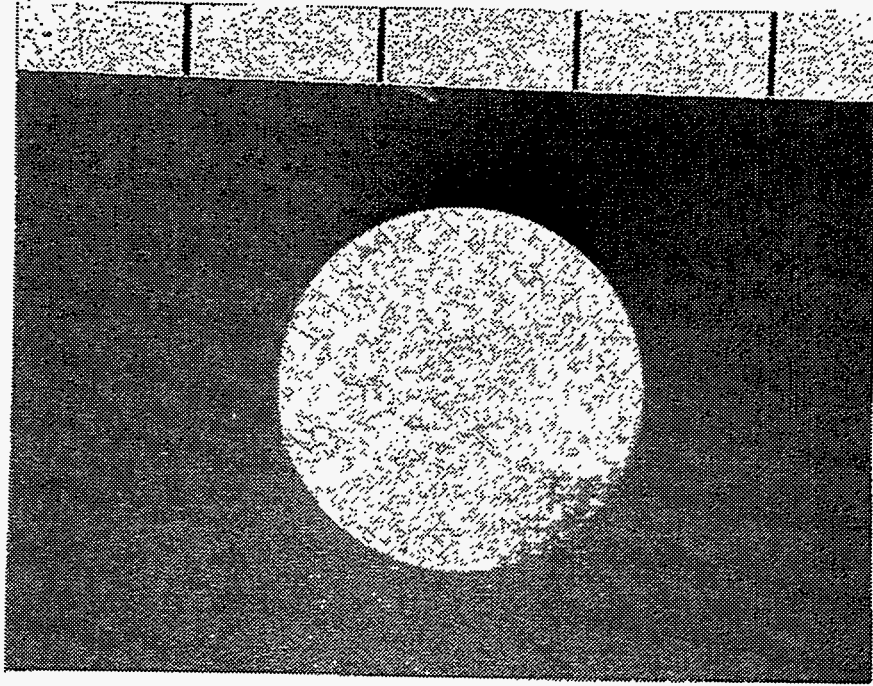






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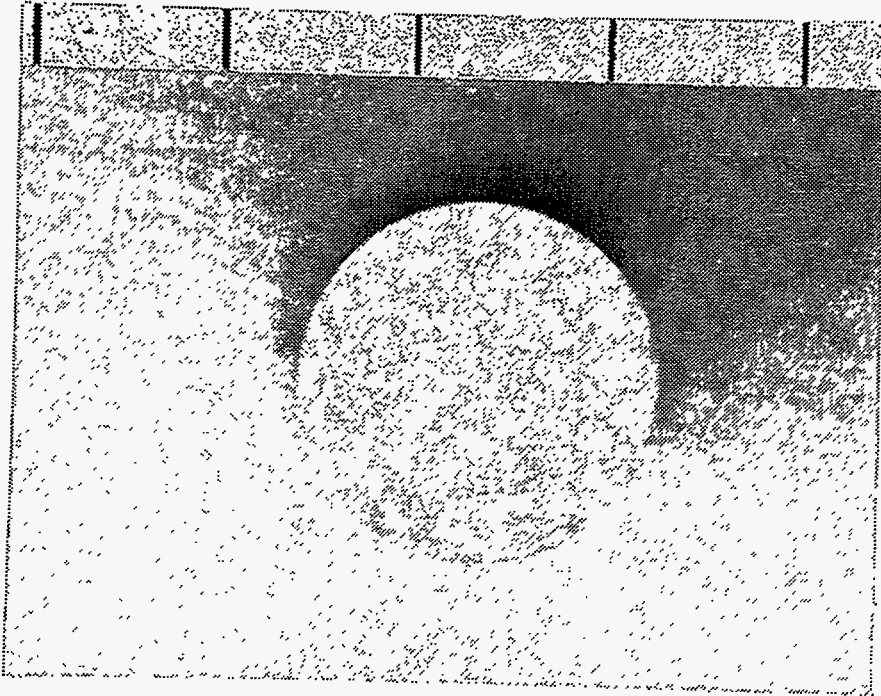
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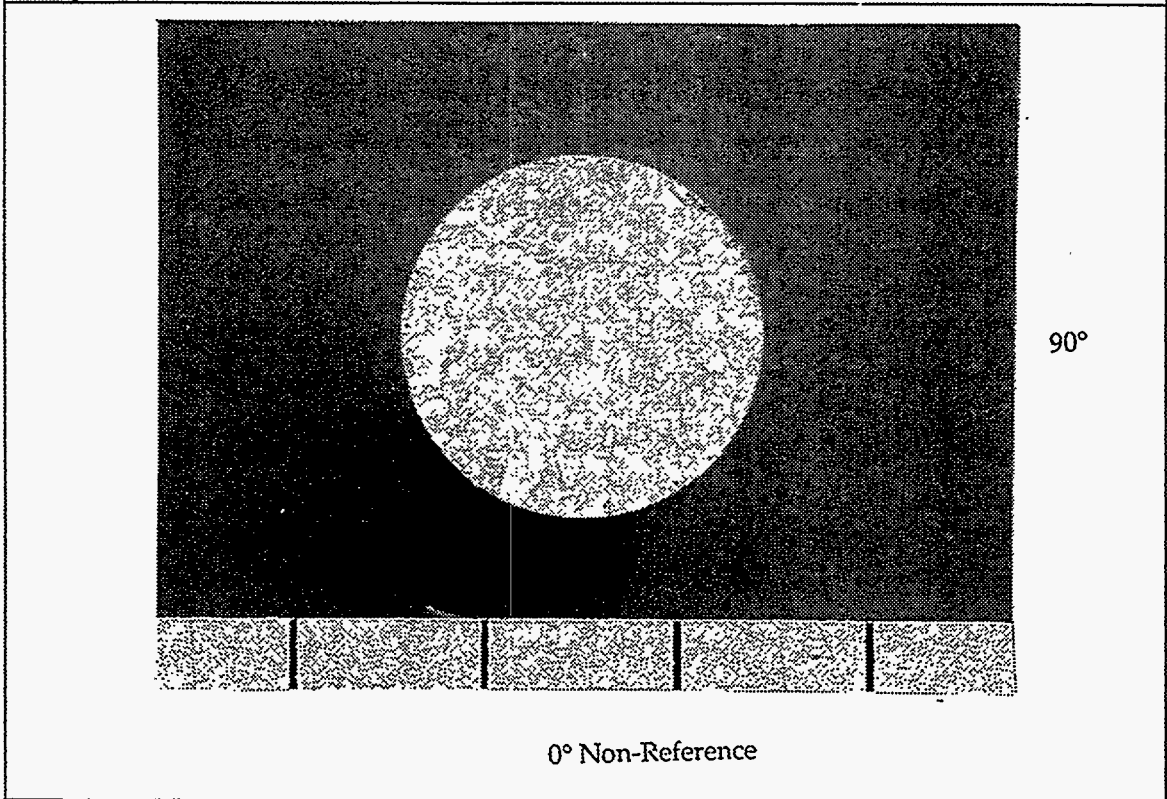
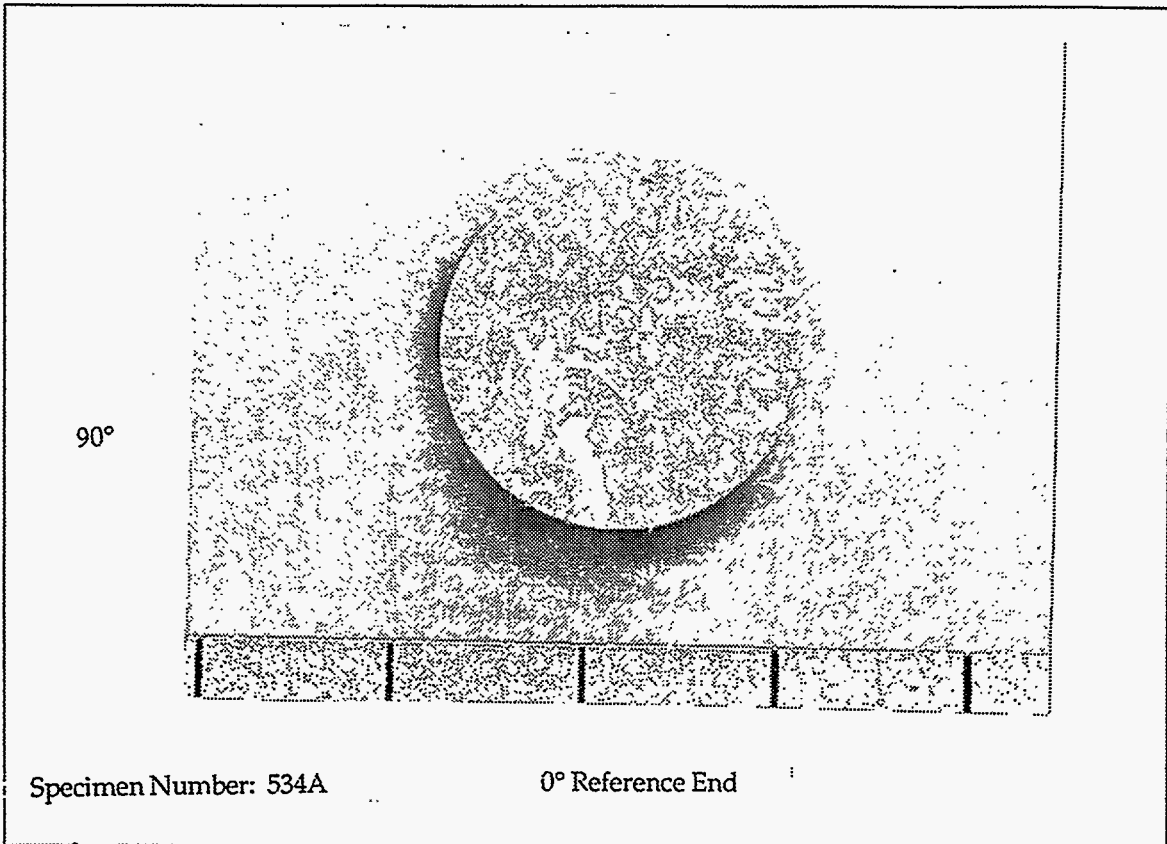


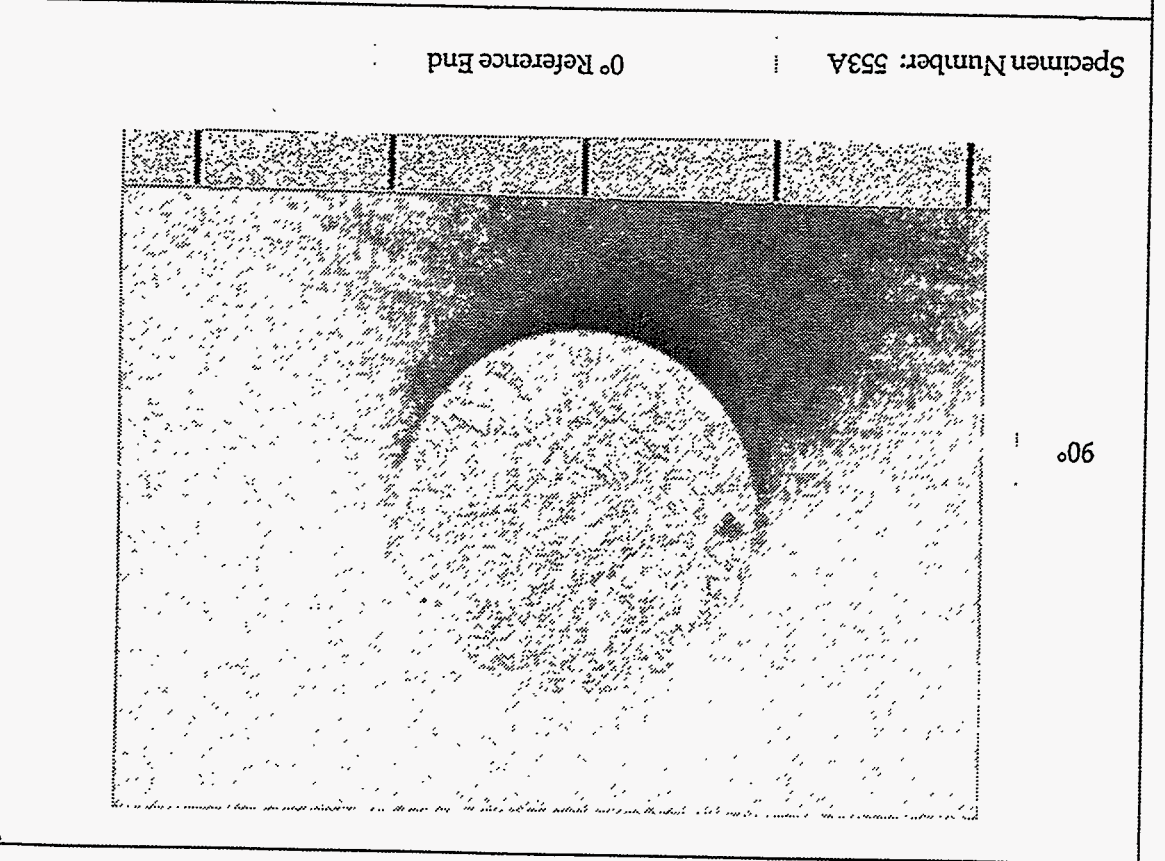
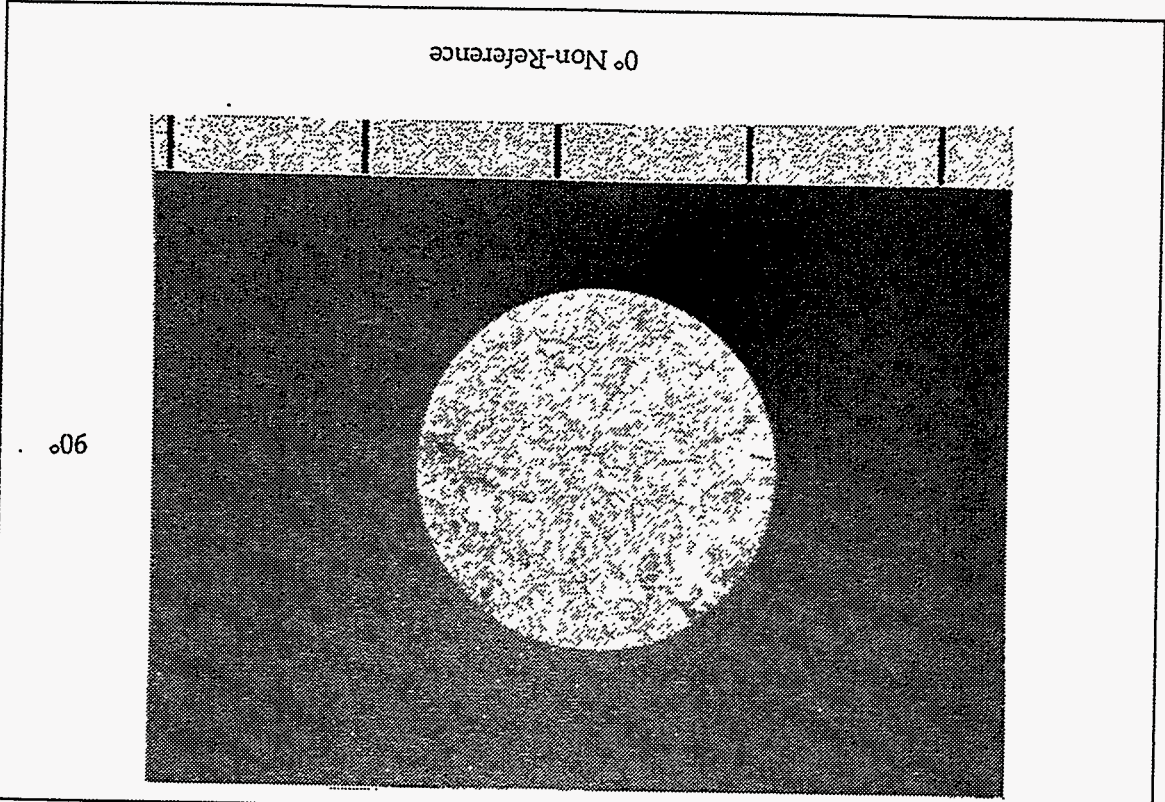
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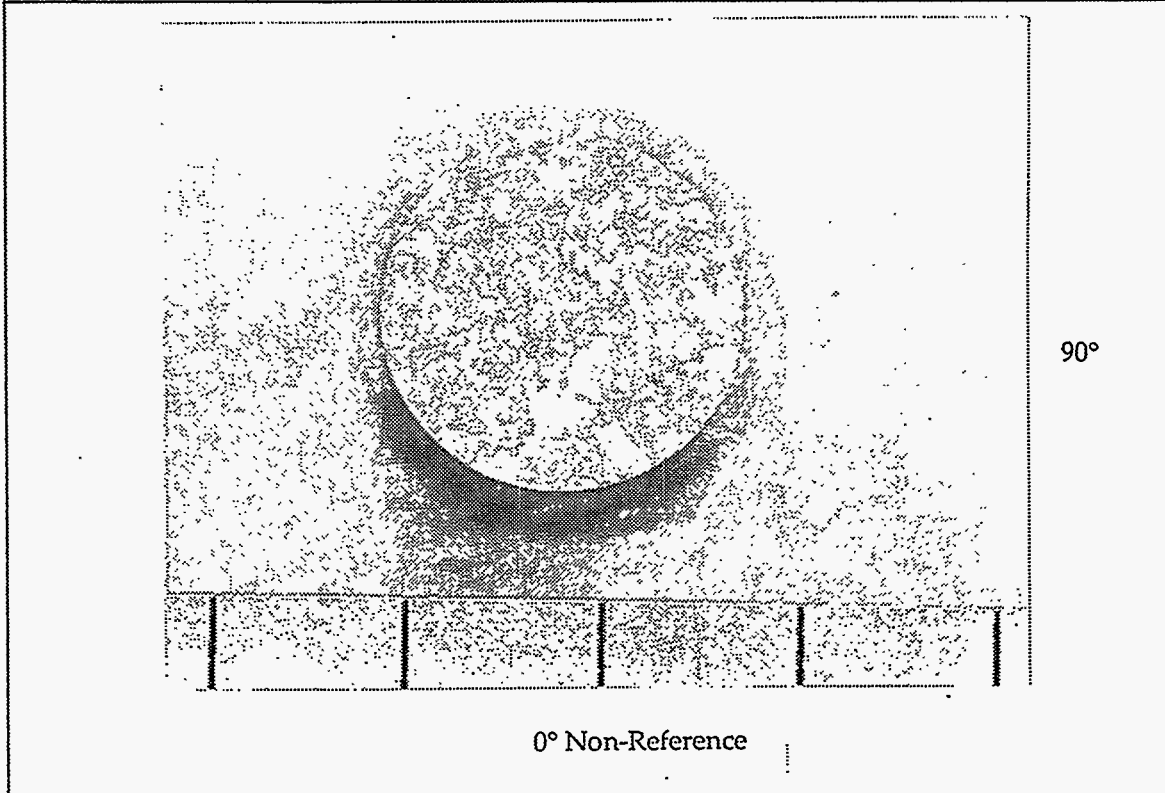
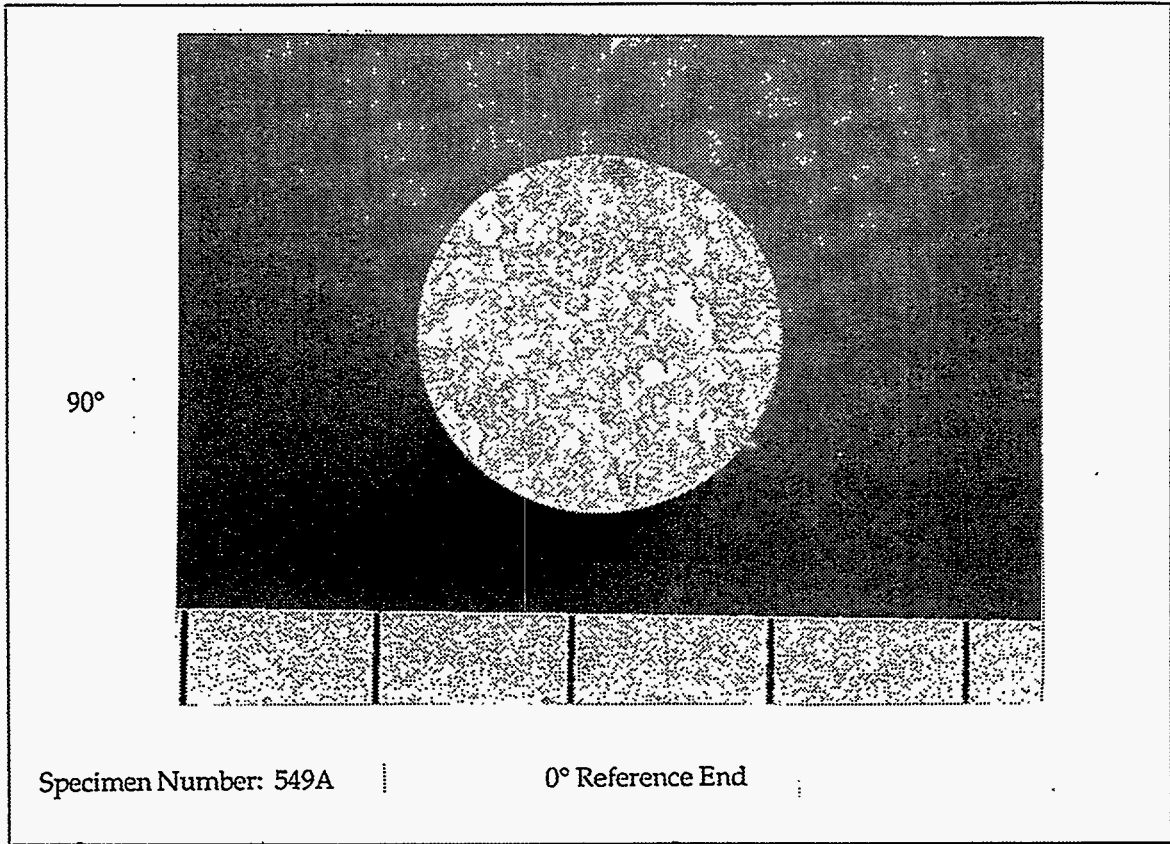
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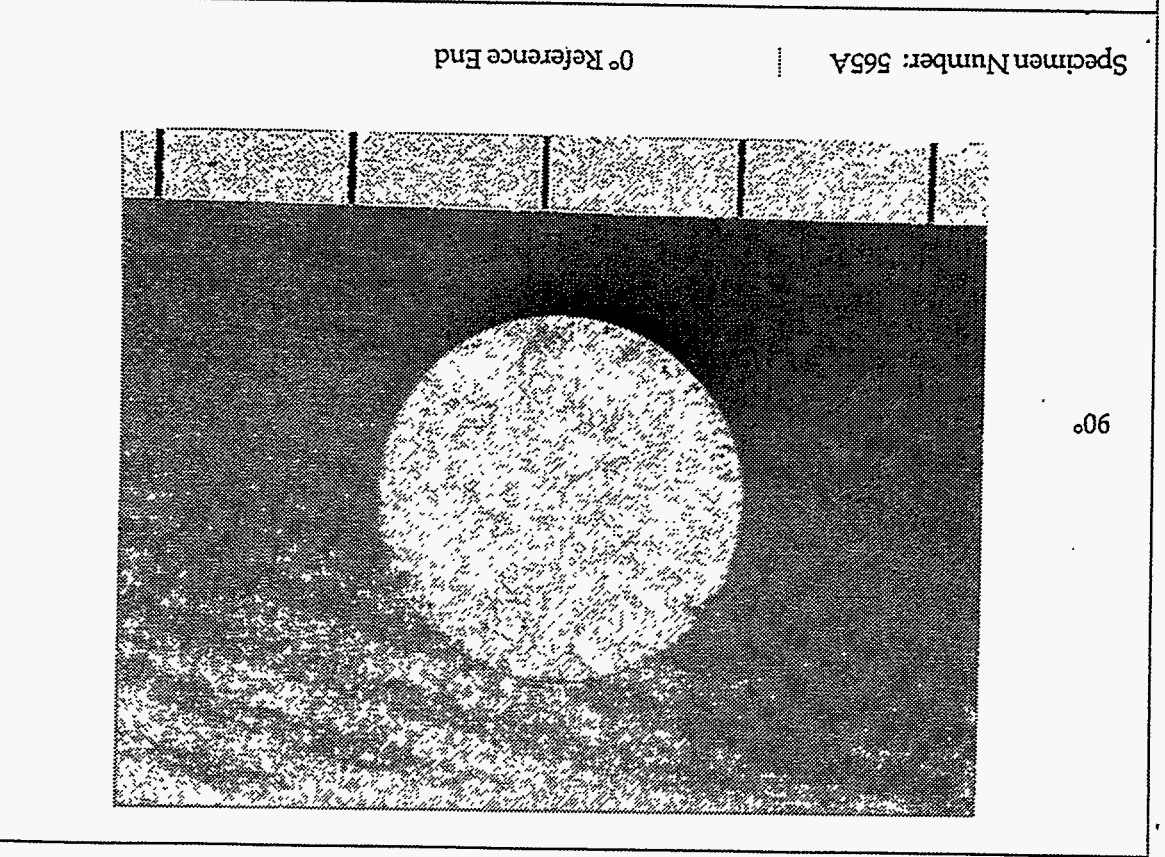
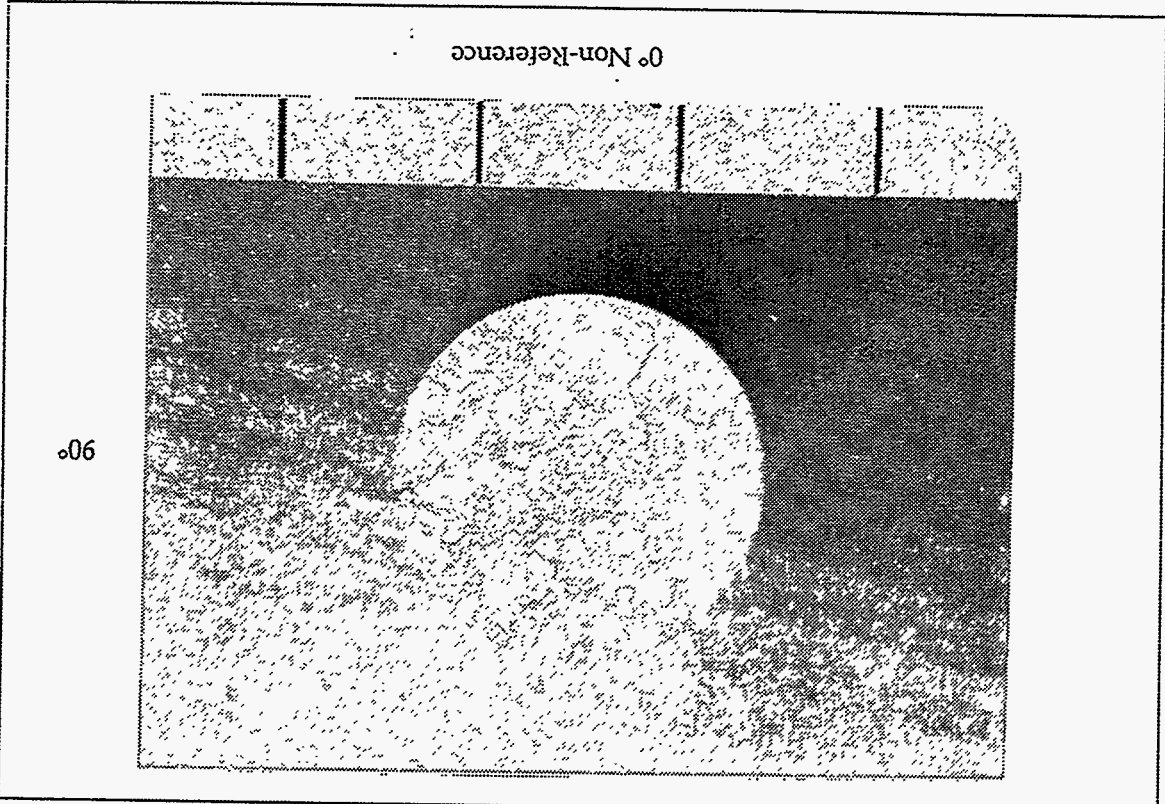
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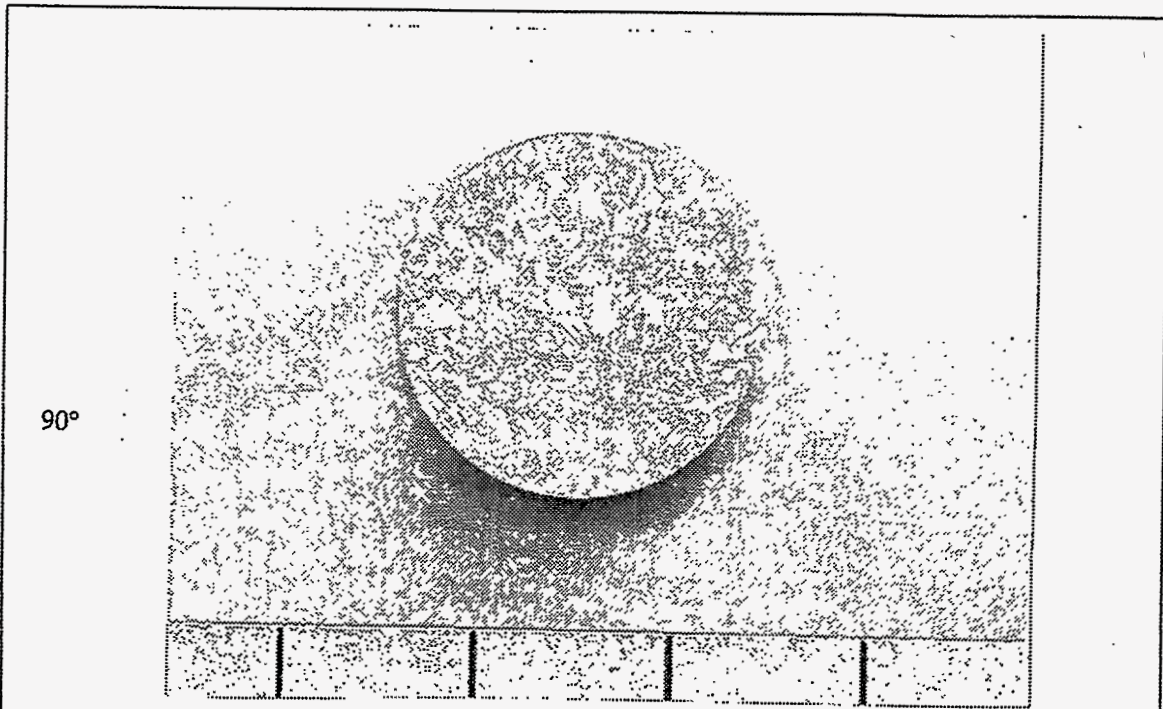






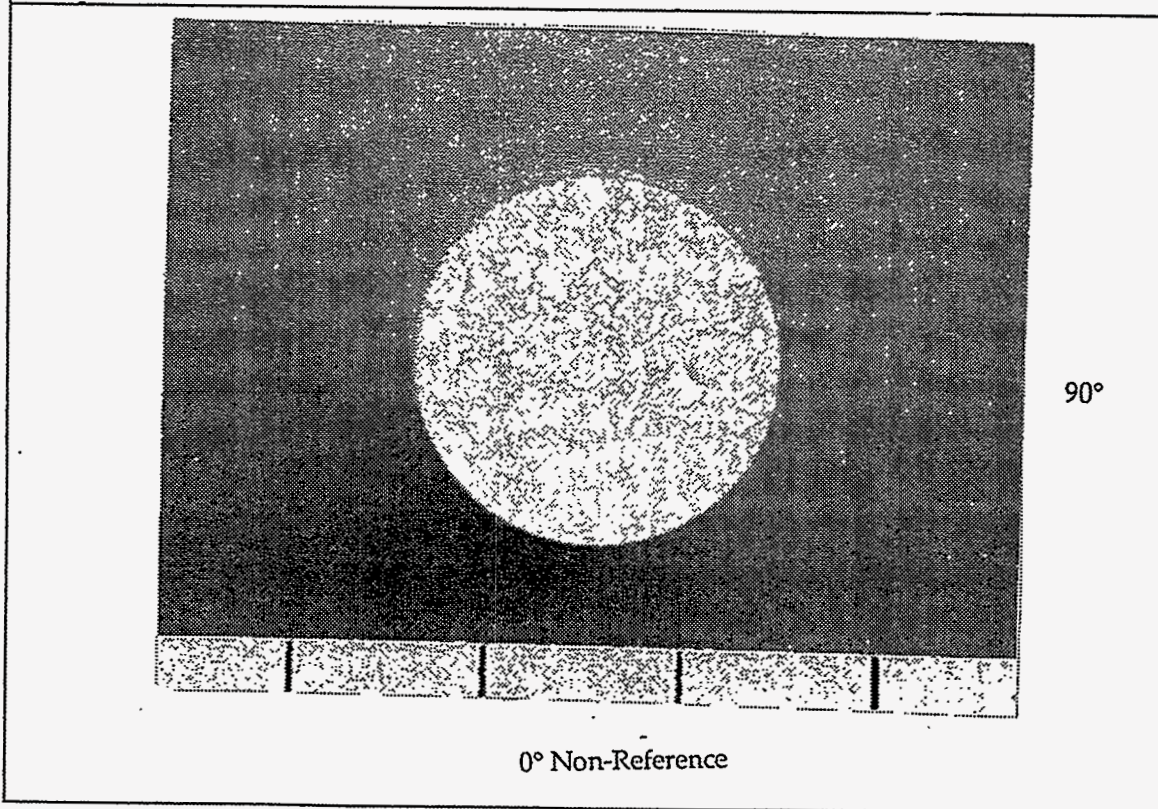






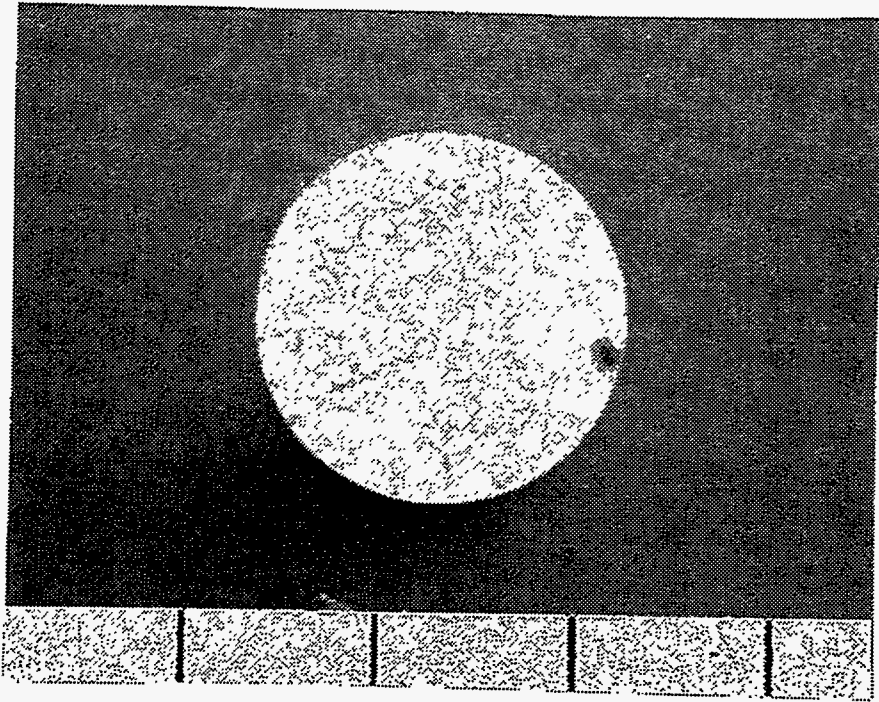
Specimen Number: 574A

0° Reference End



0° Non-Reference

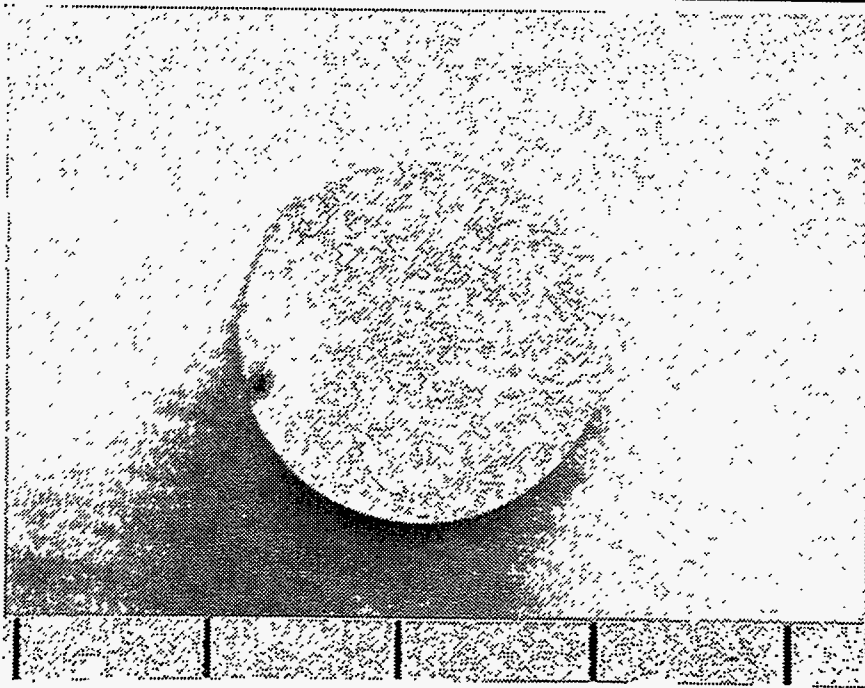
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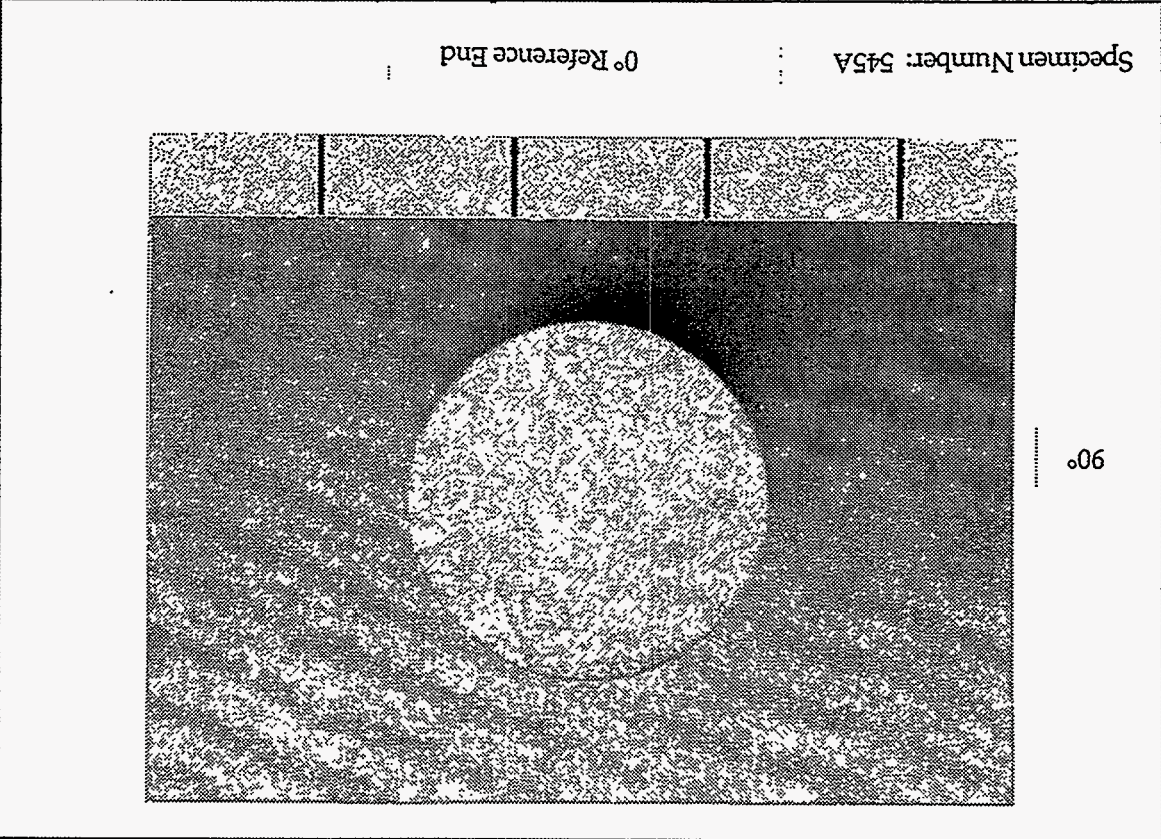
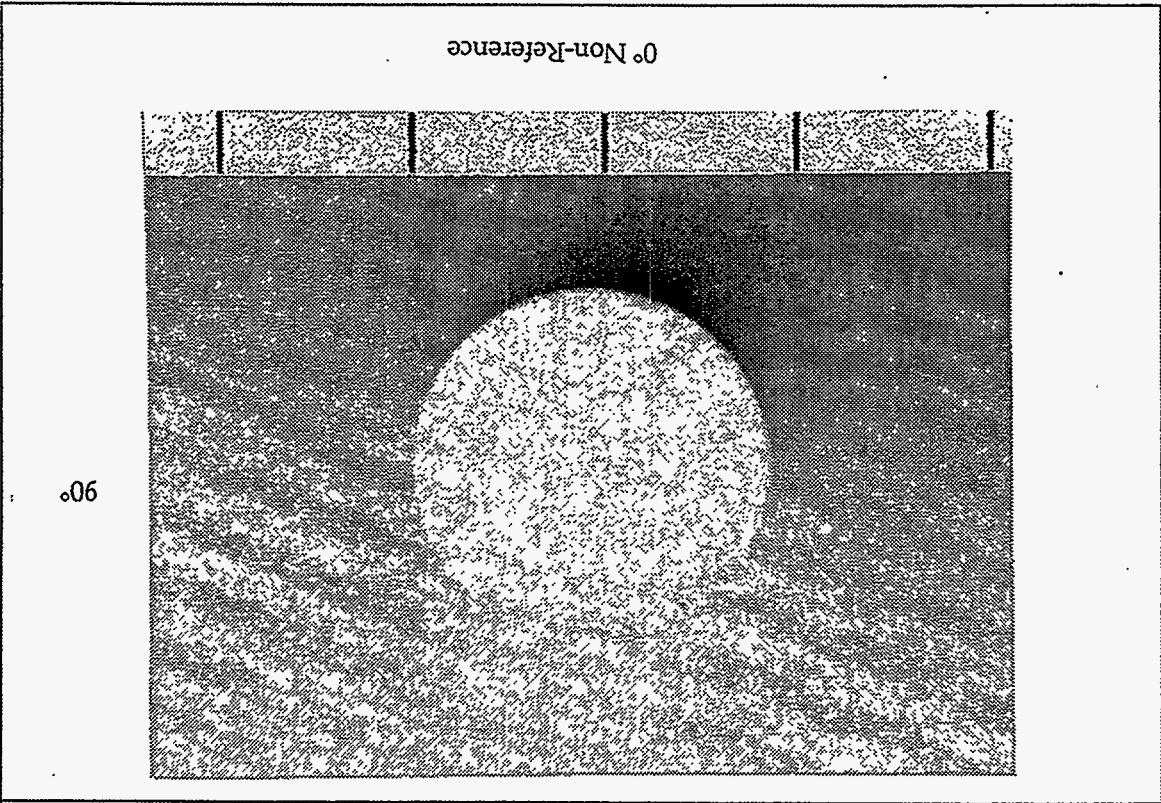
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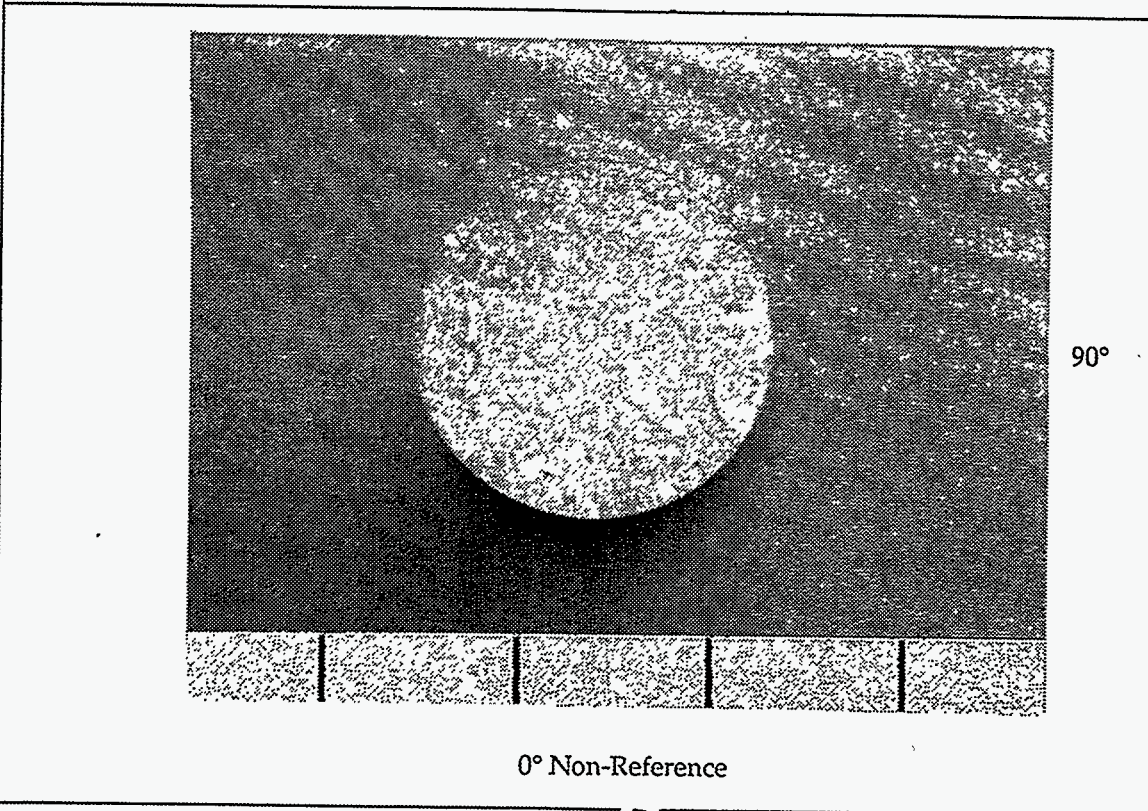
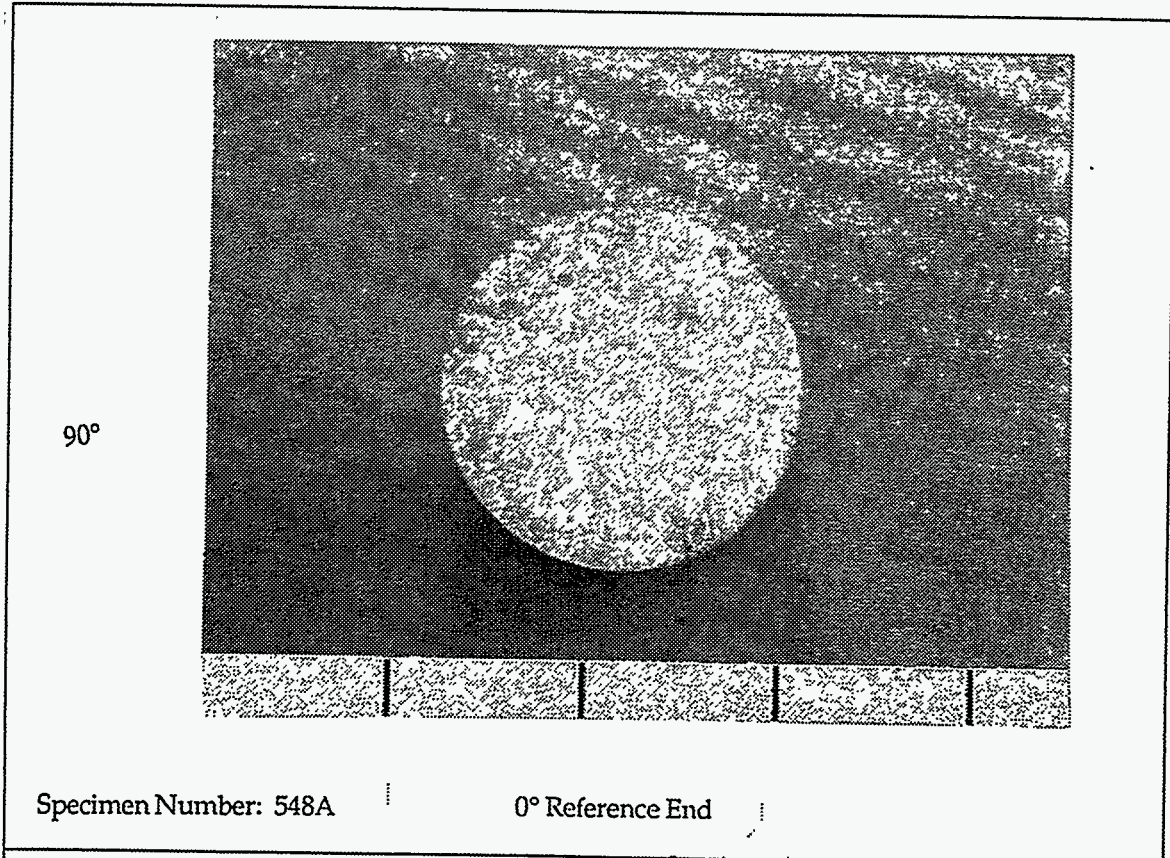
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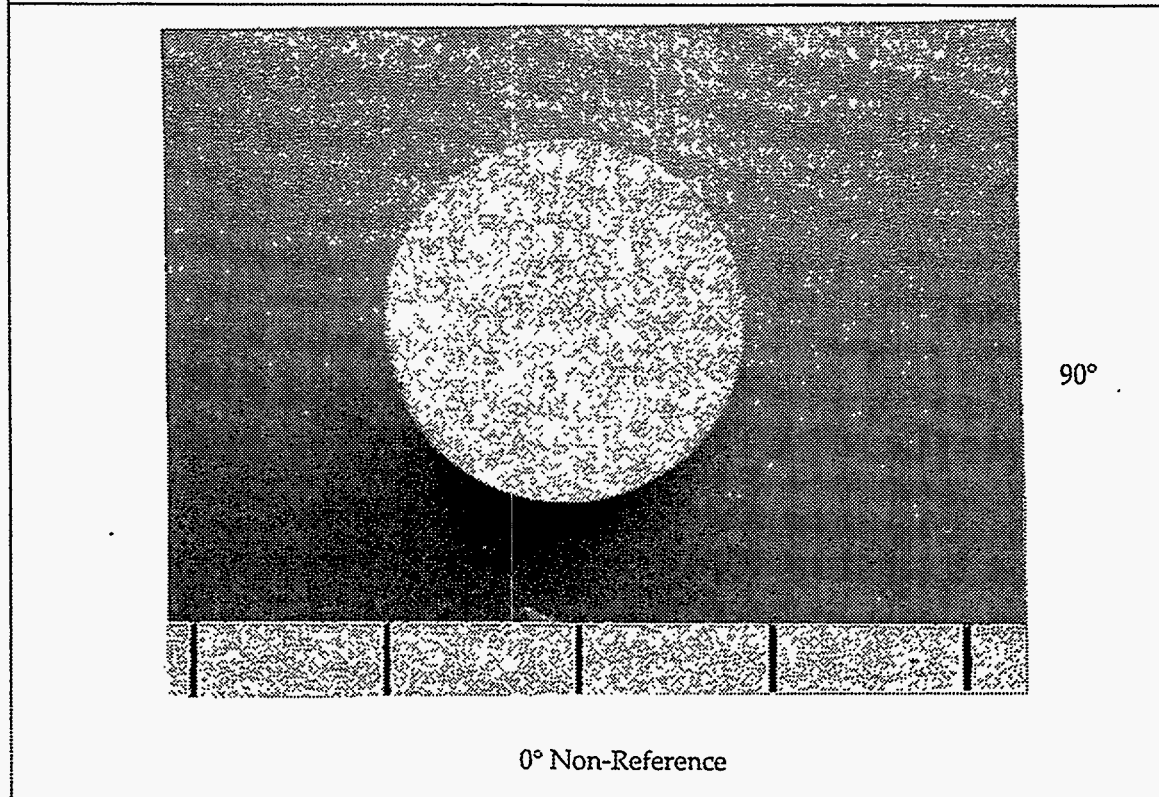
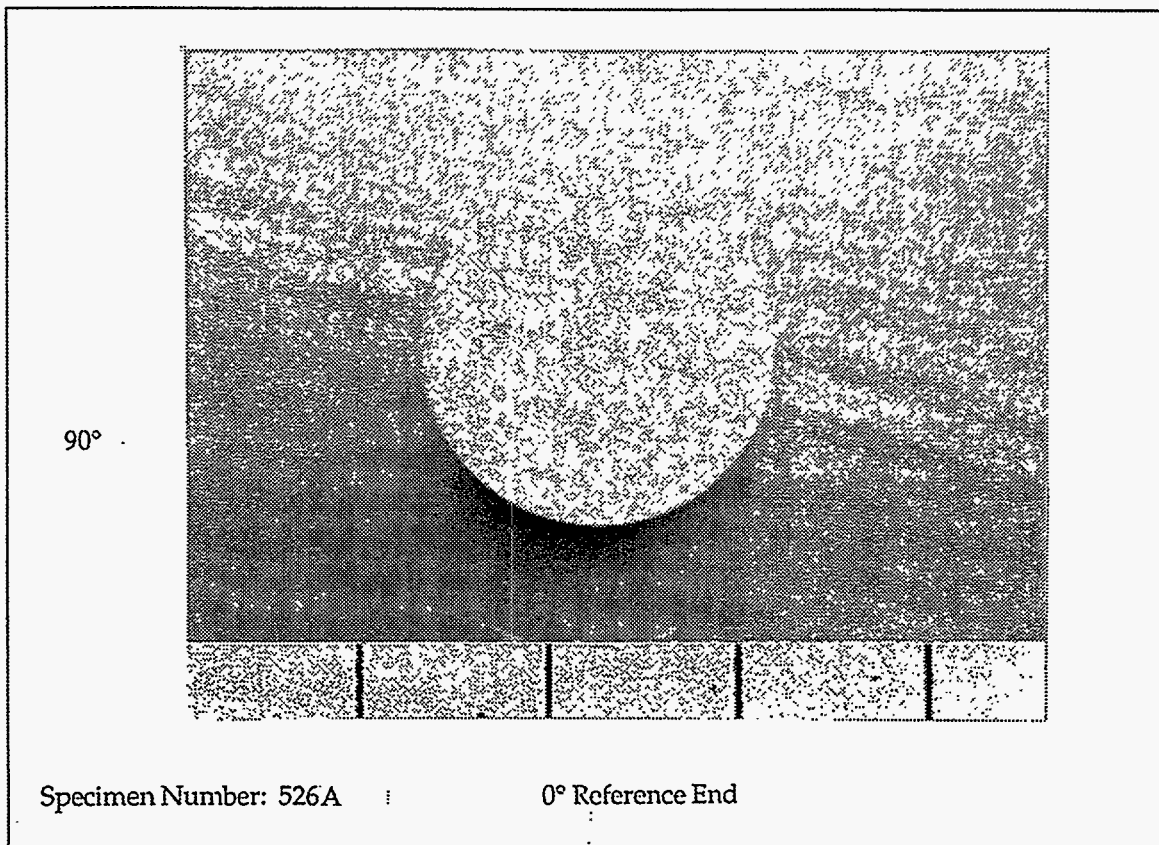
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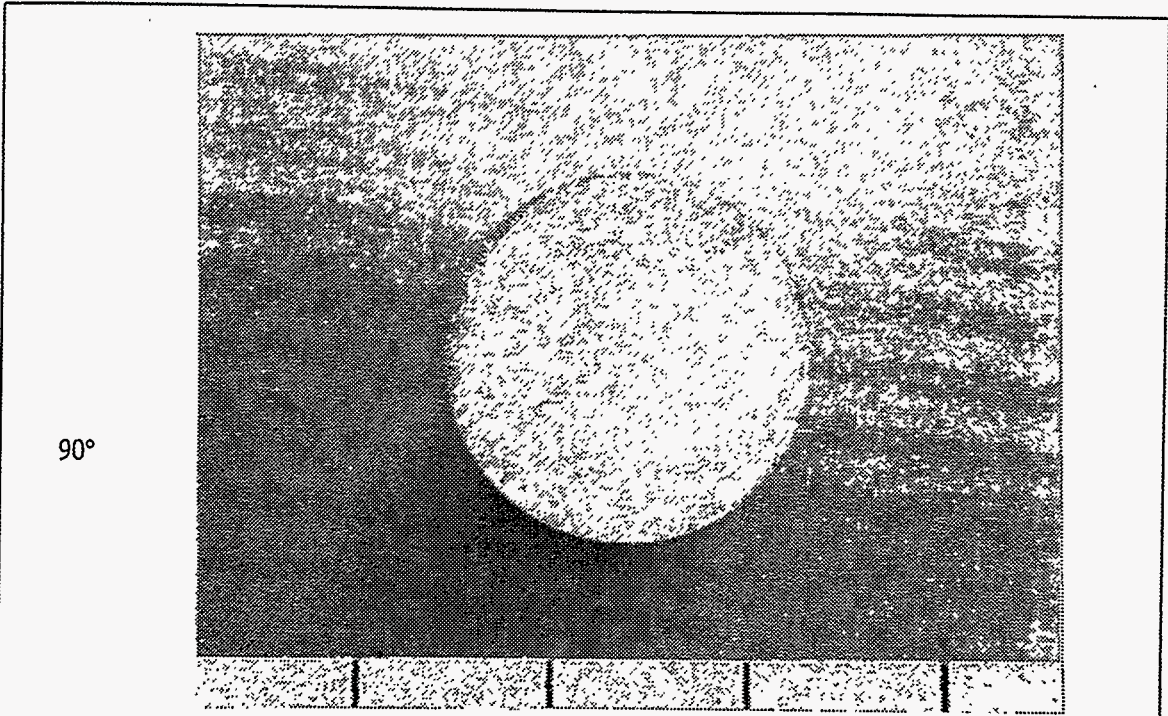


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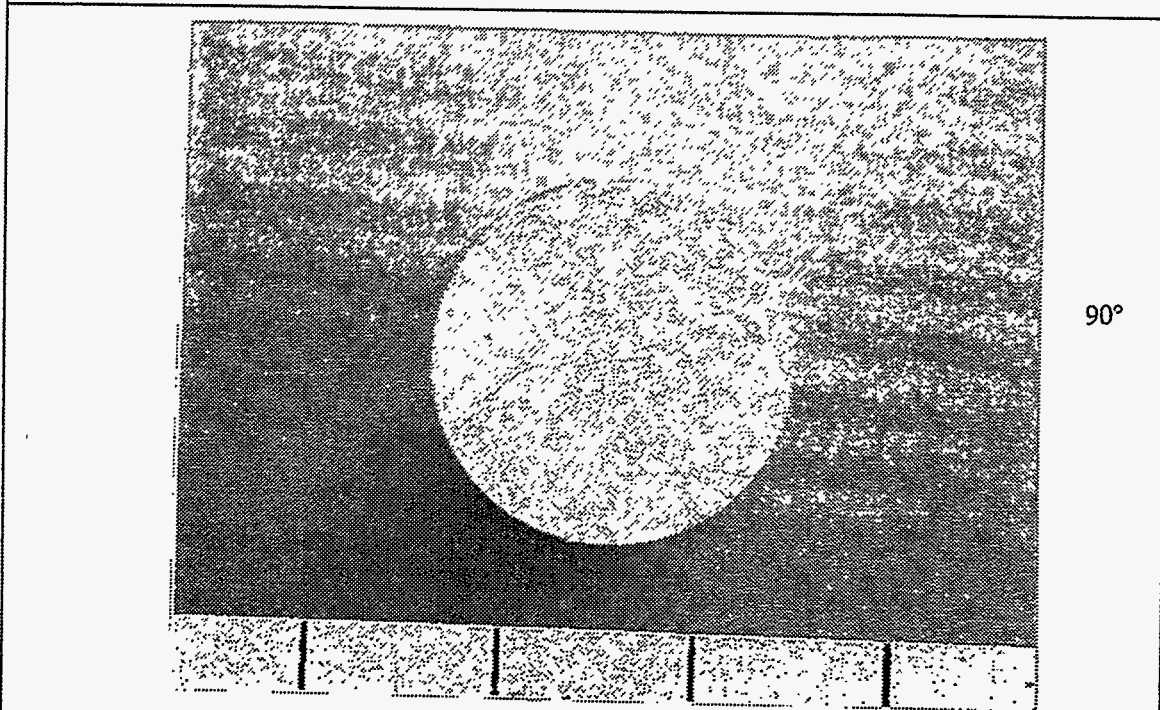




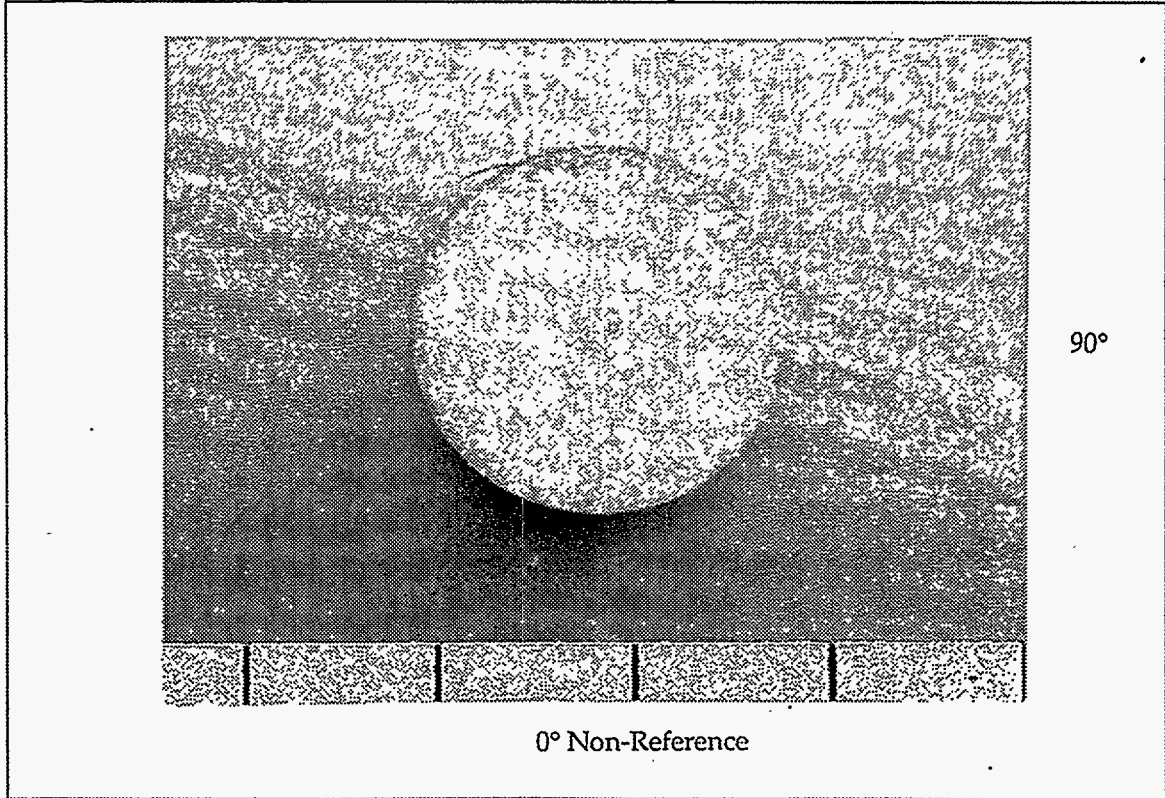
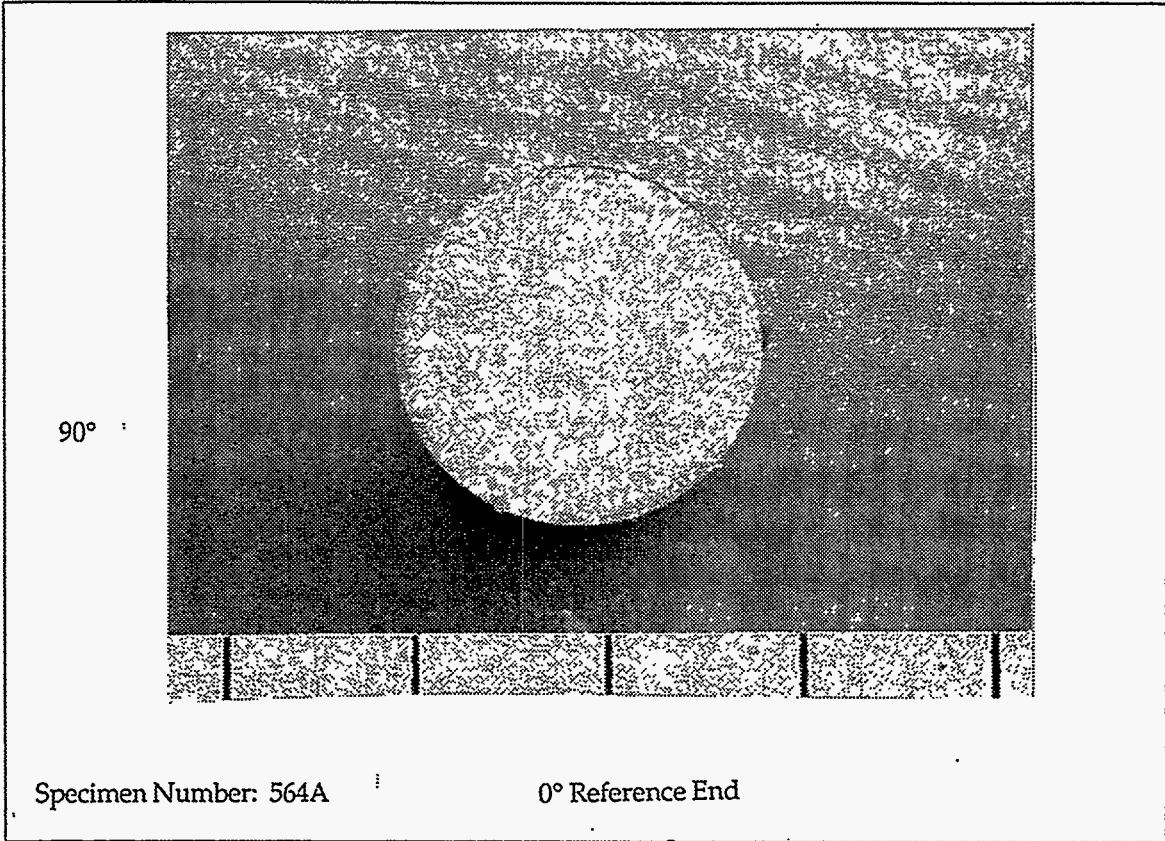


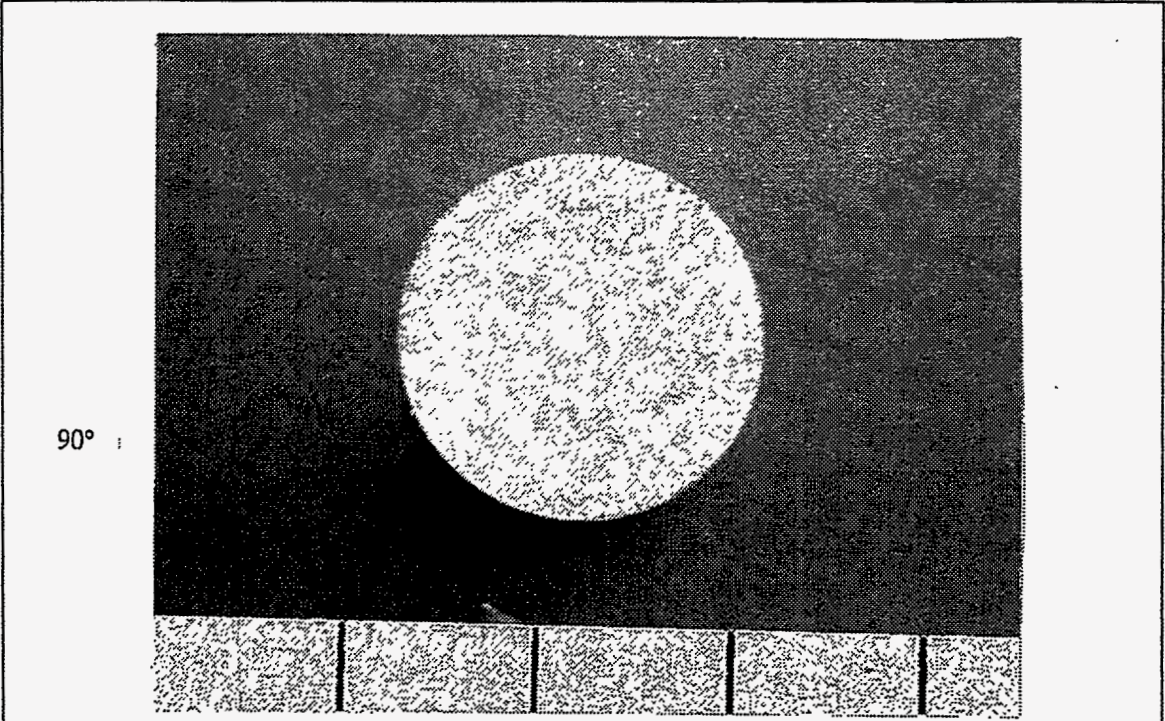
Specimen Number: 571A

0° Reference End



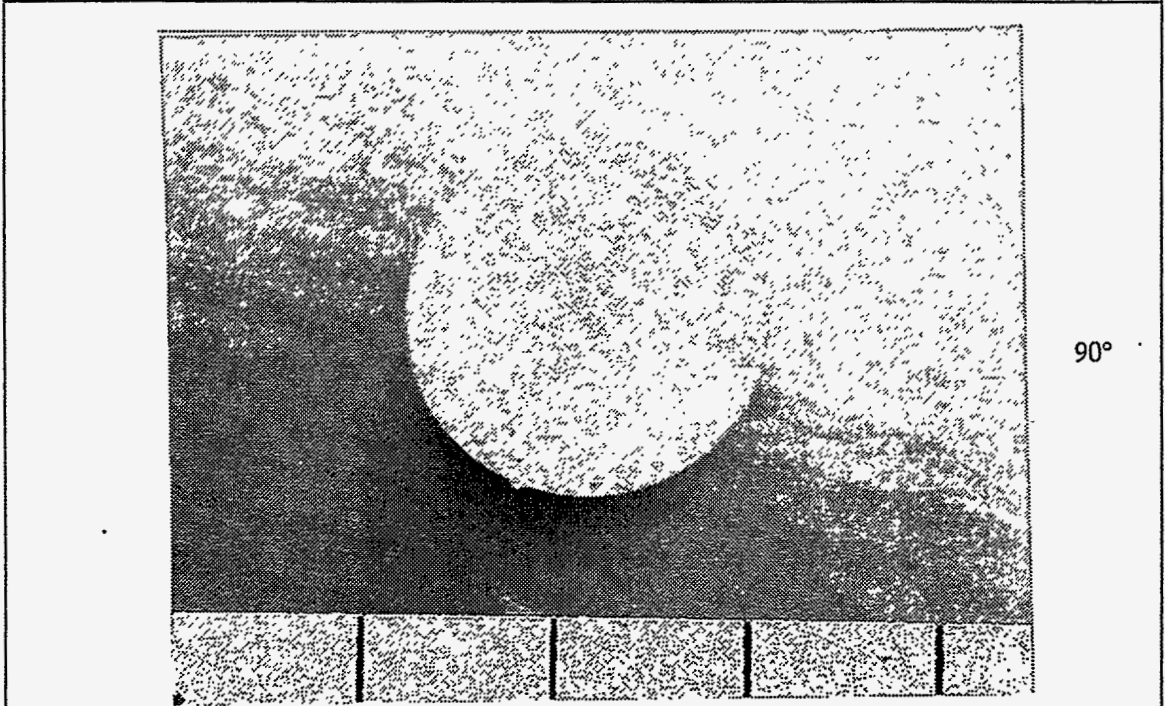
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Specimen Number: 81C

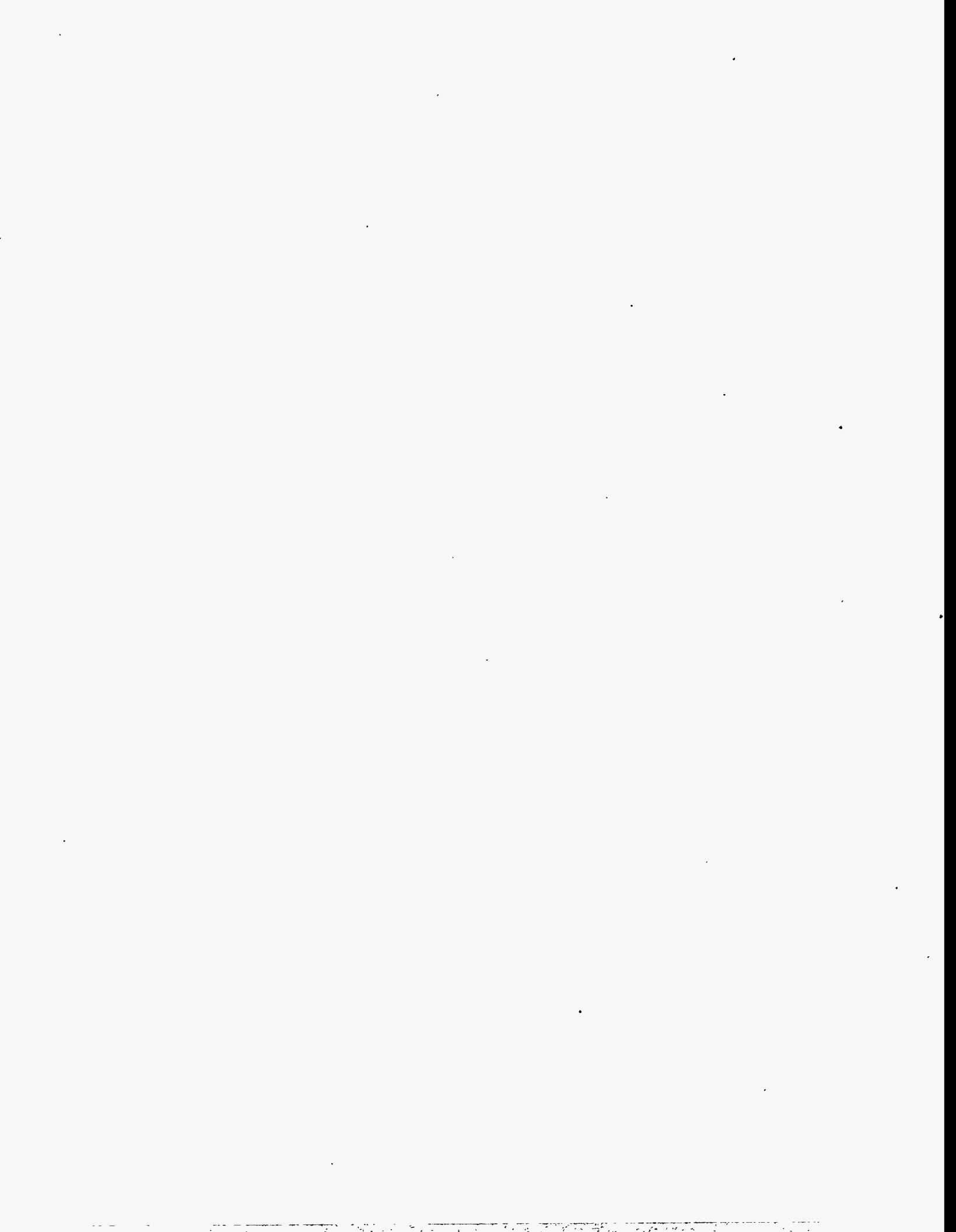
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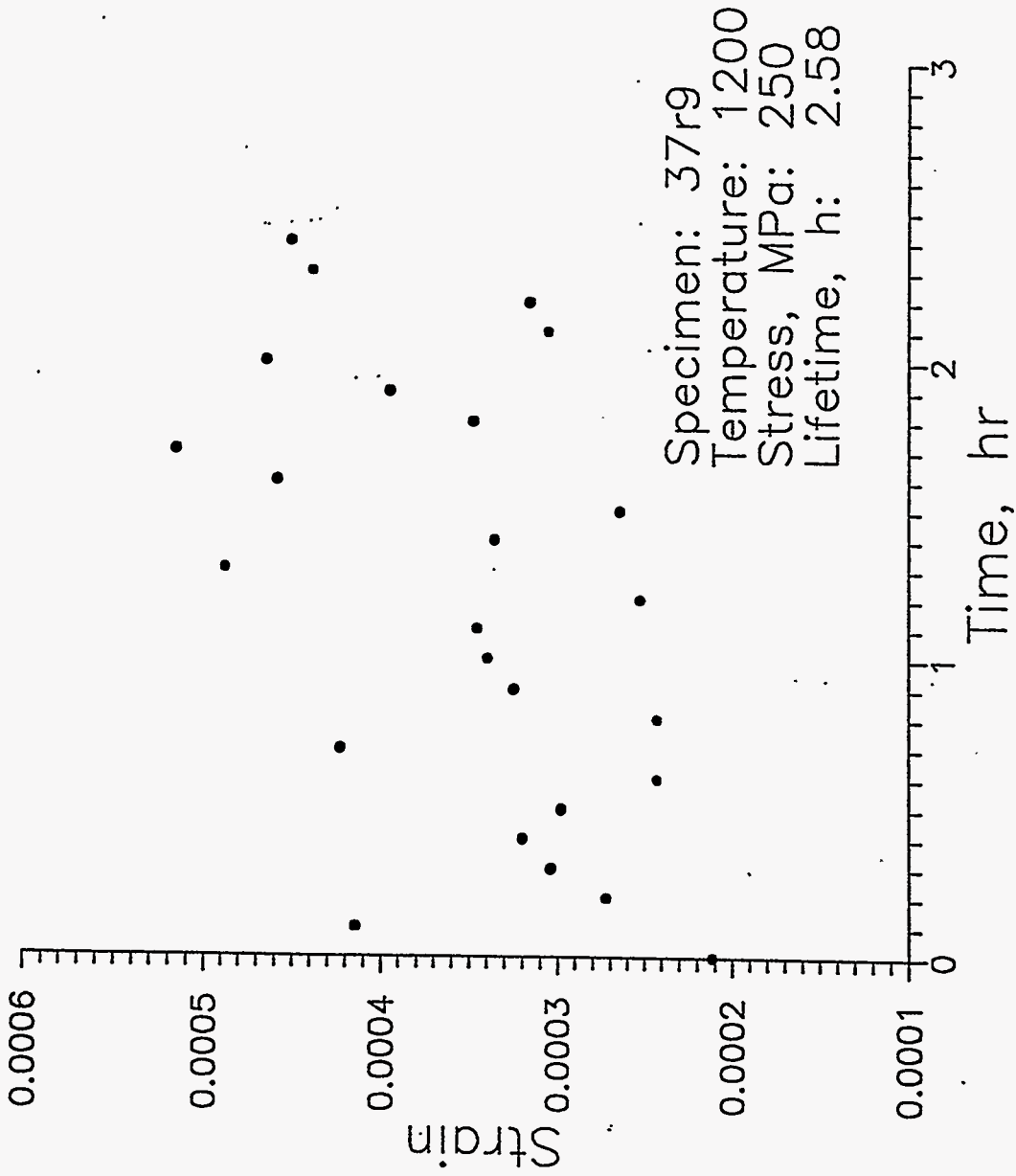


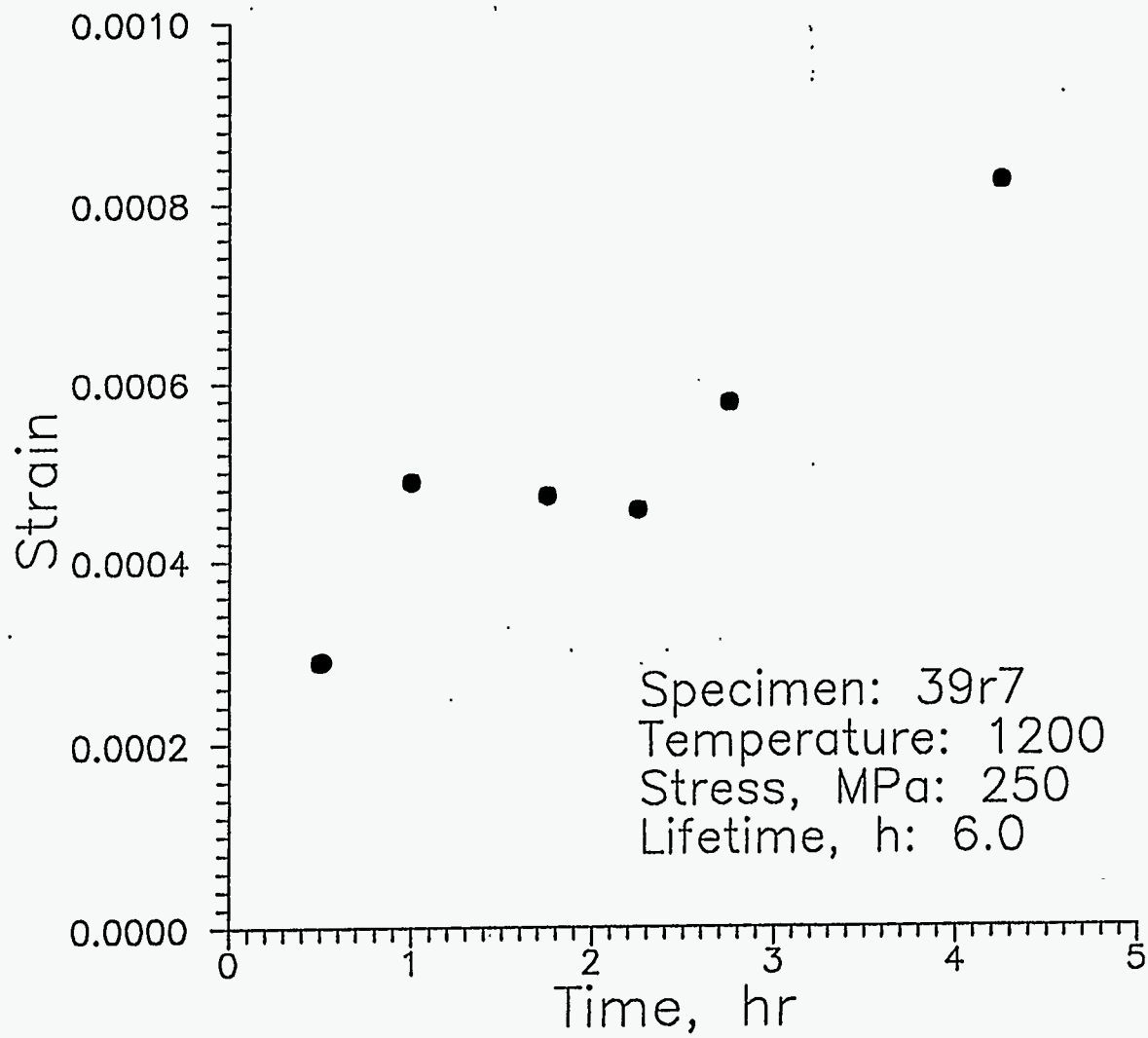
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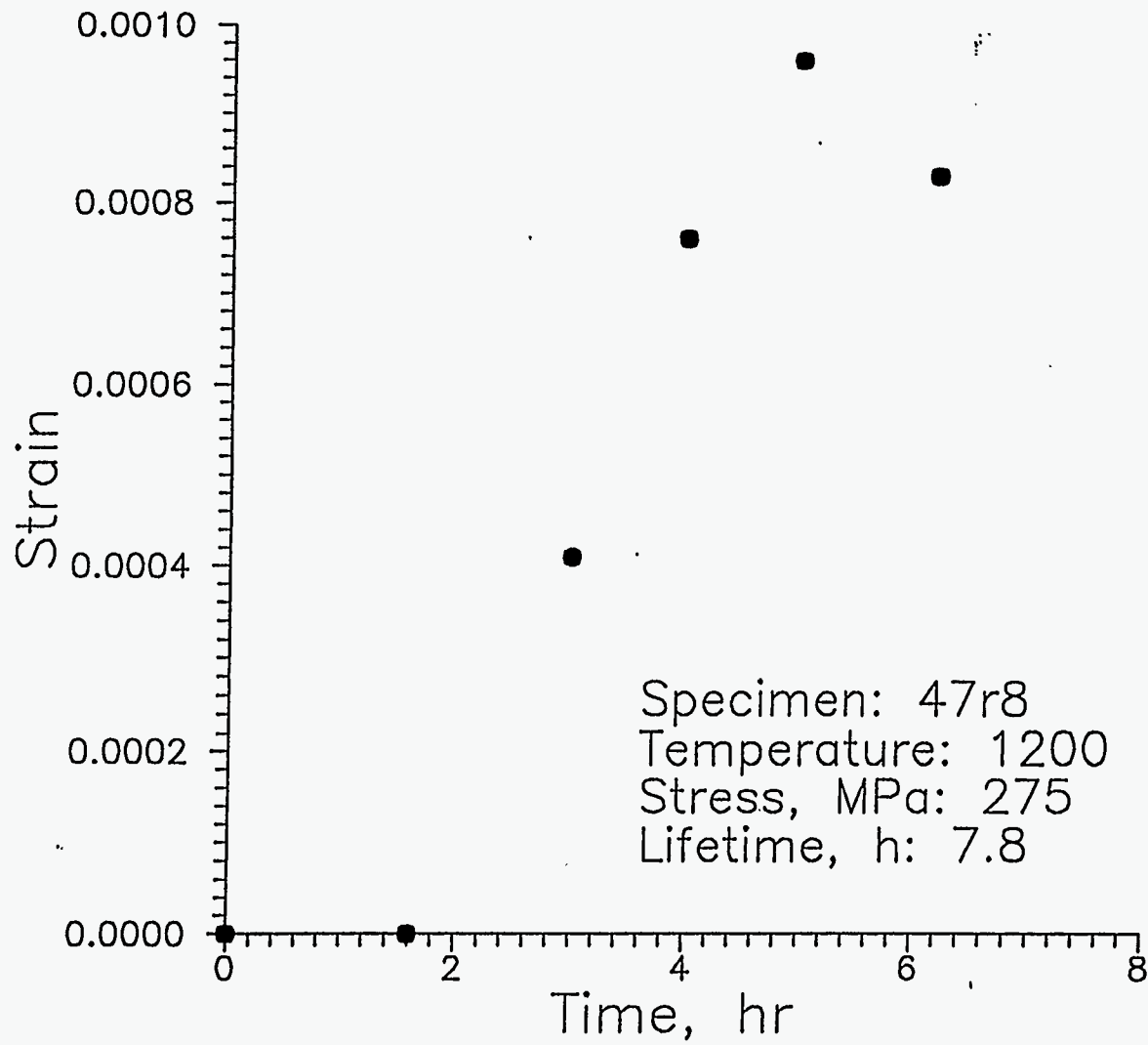
APPENDIX VI

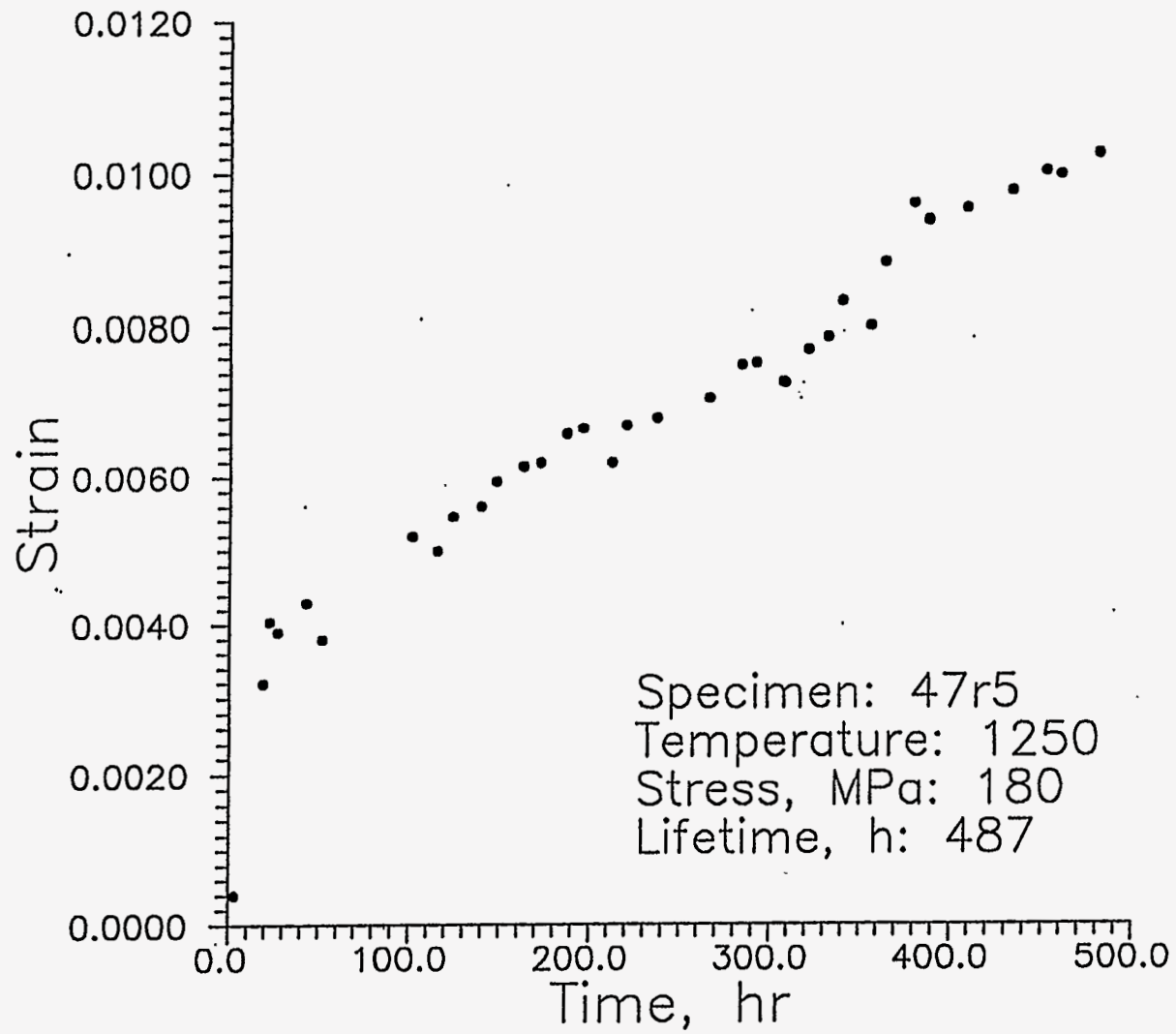
**TENSILE CREEP CURVES FOR DOGBONE SPECIMENS TESTED AT THE
NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY**

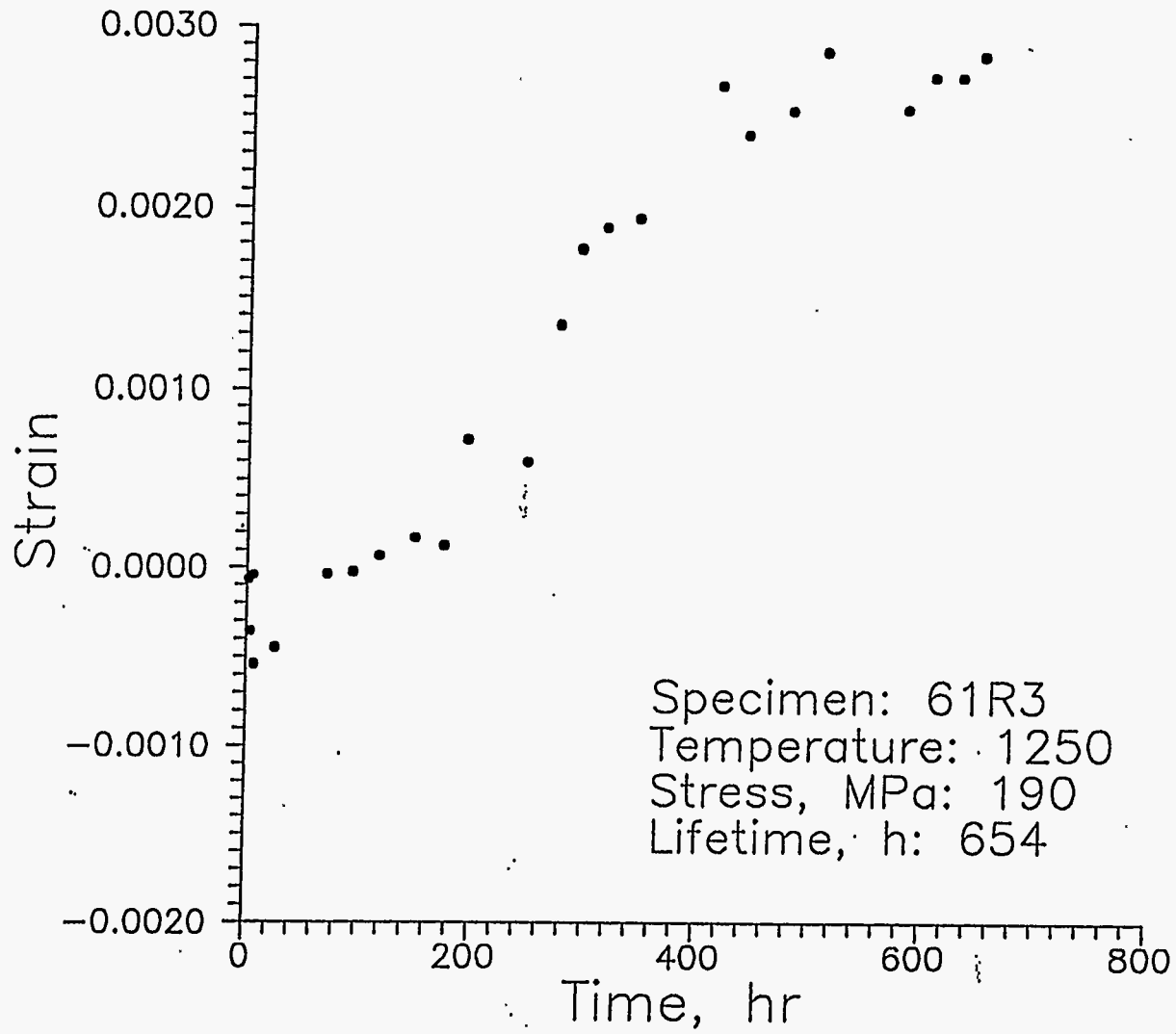


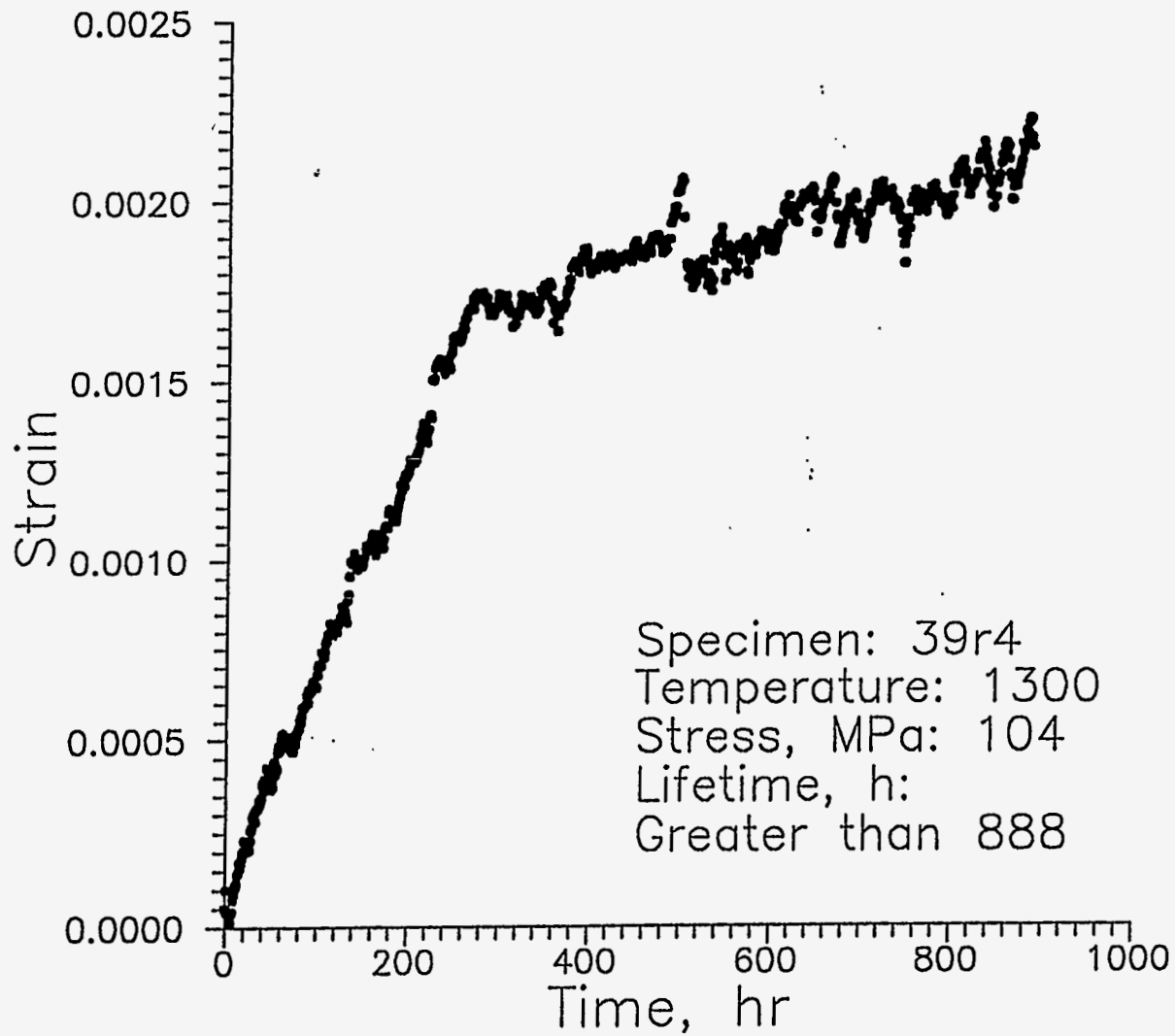


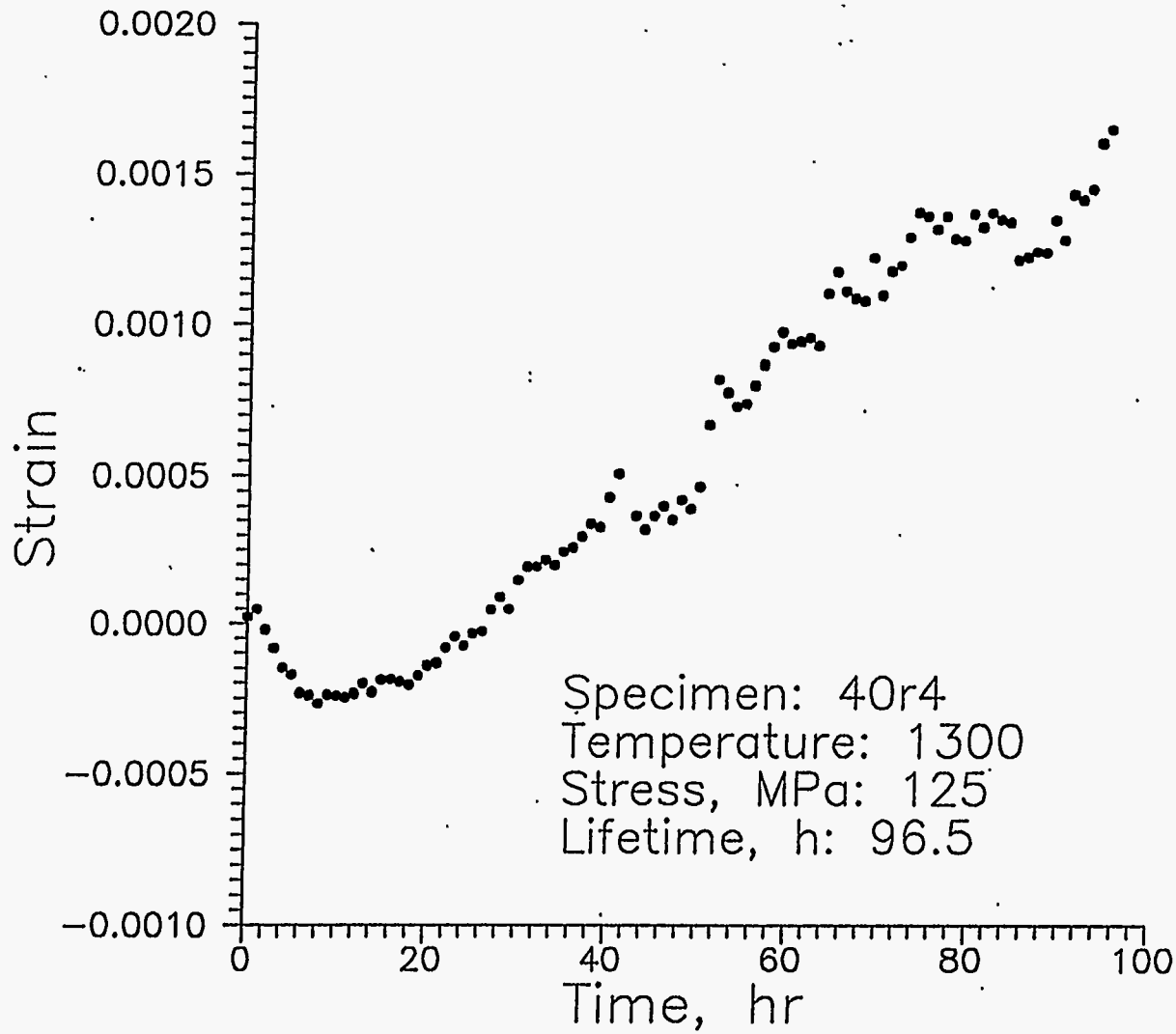


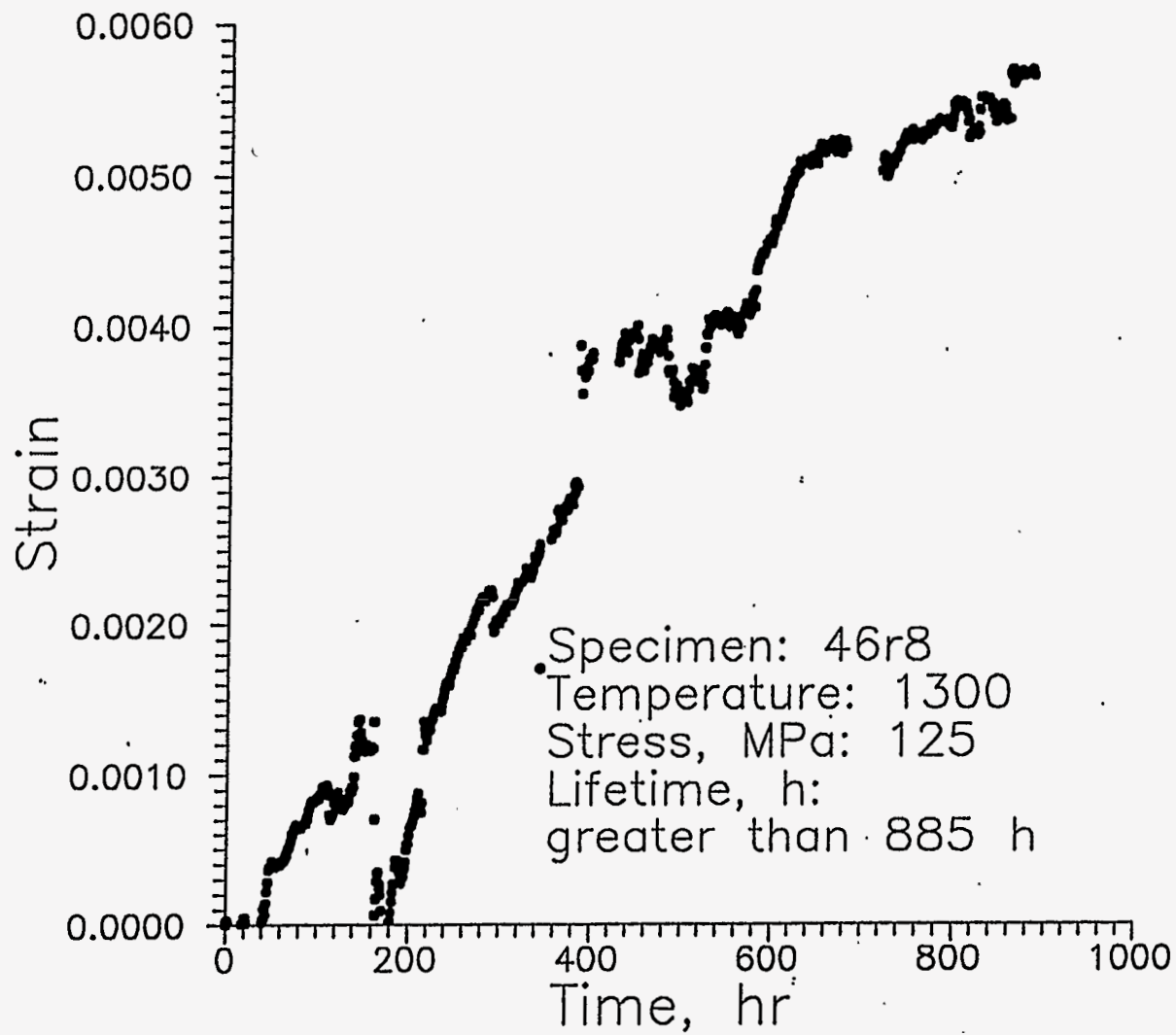


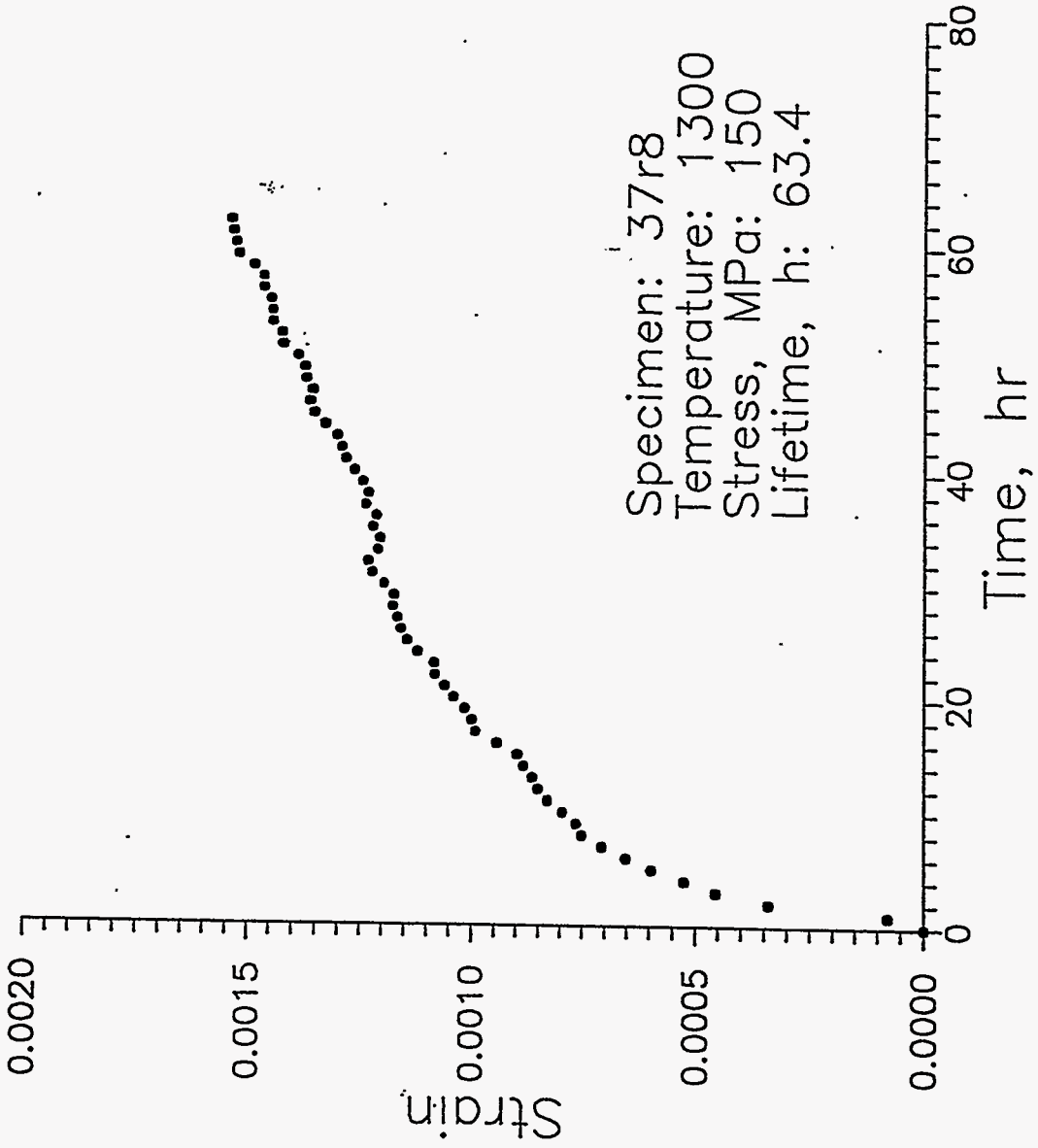


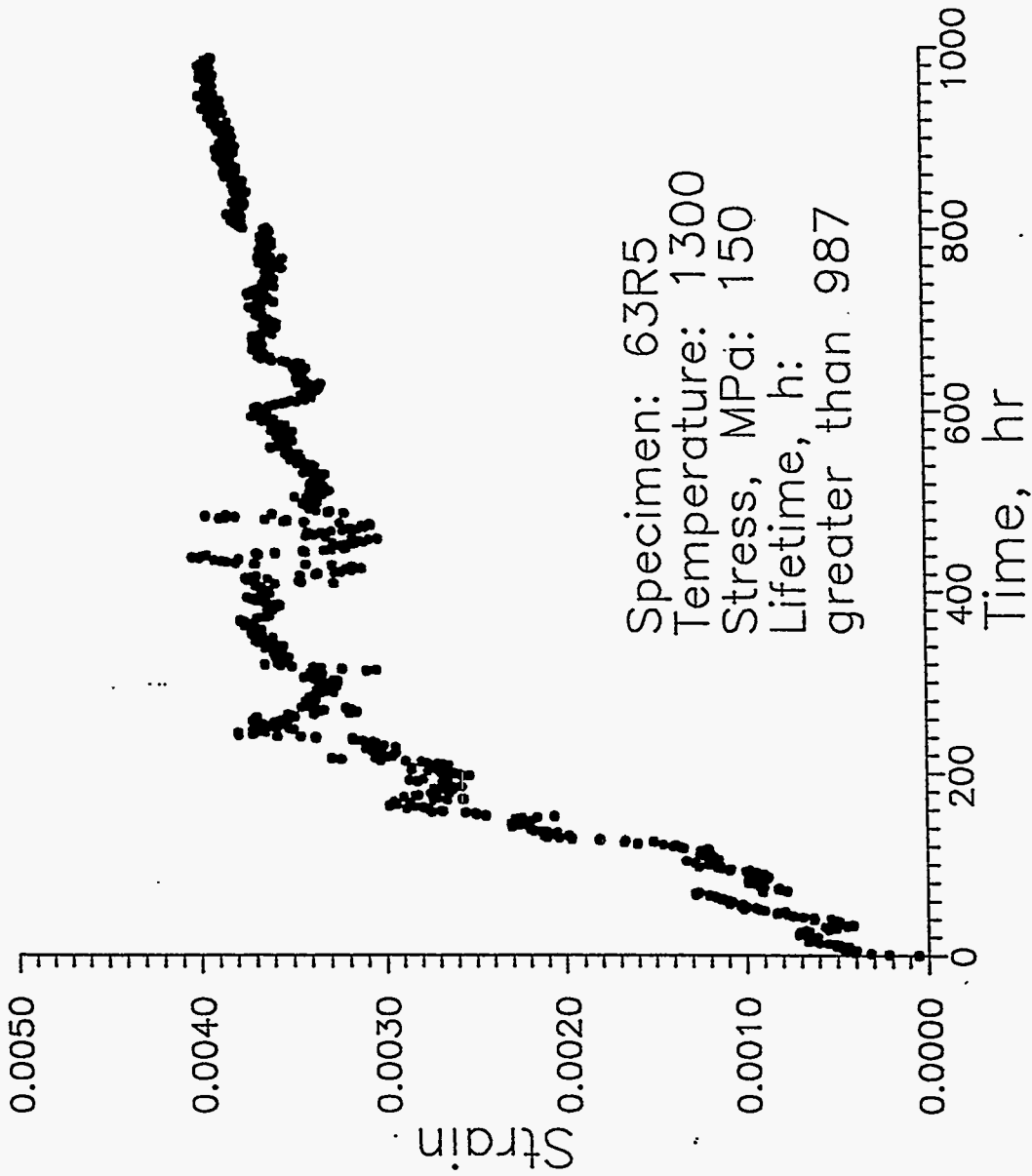




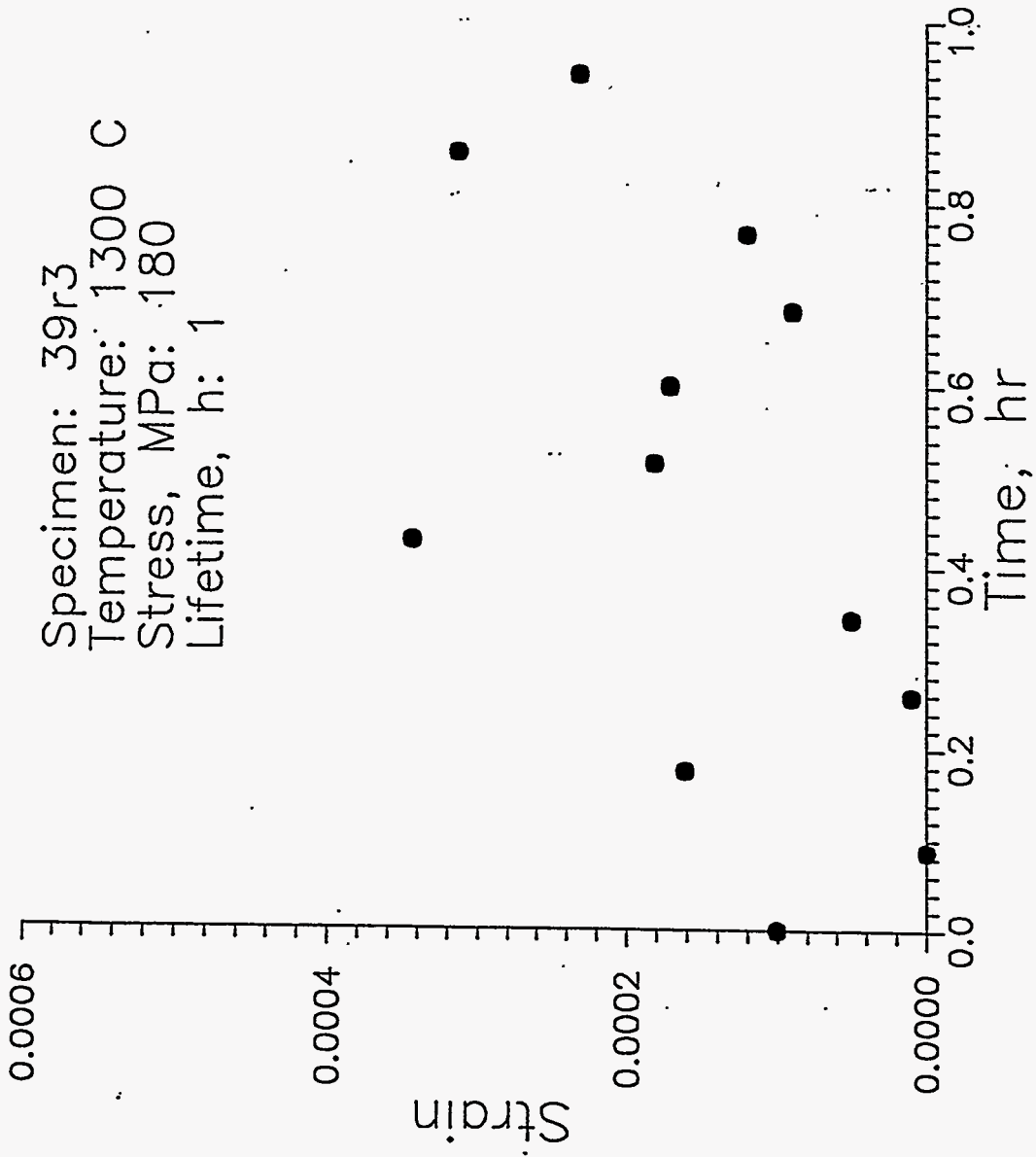


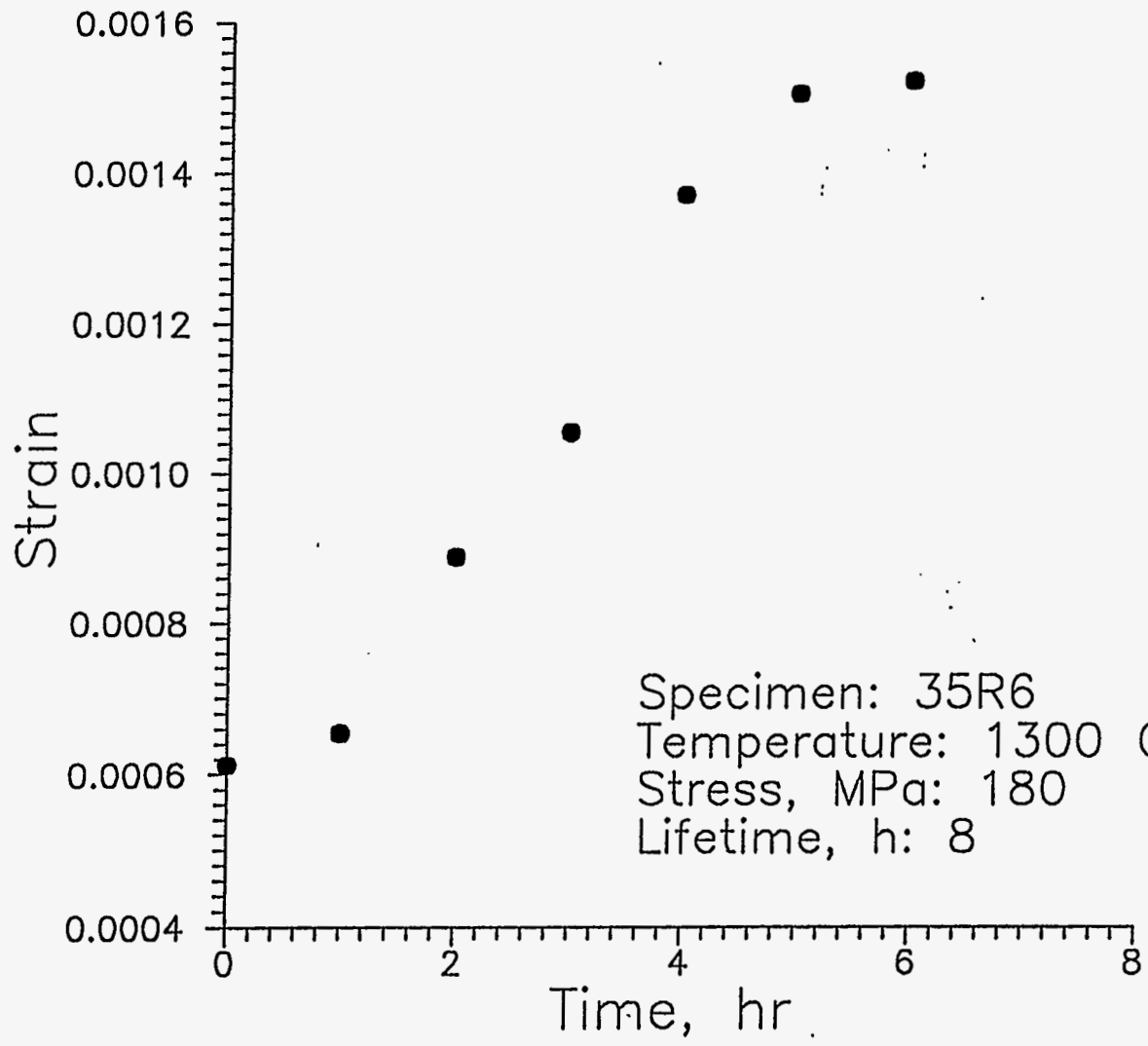




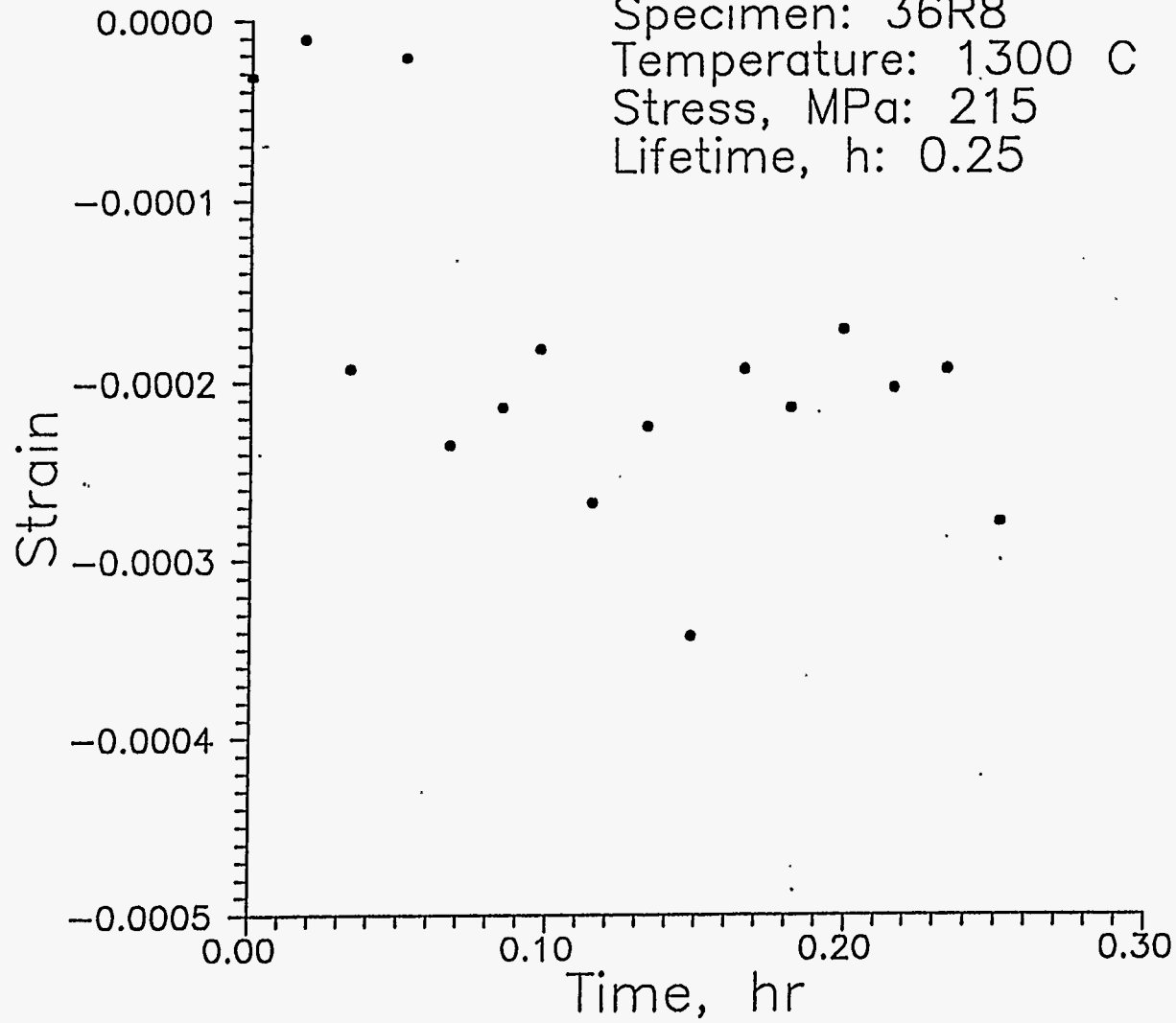


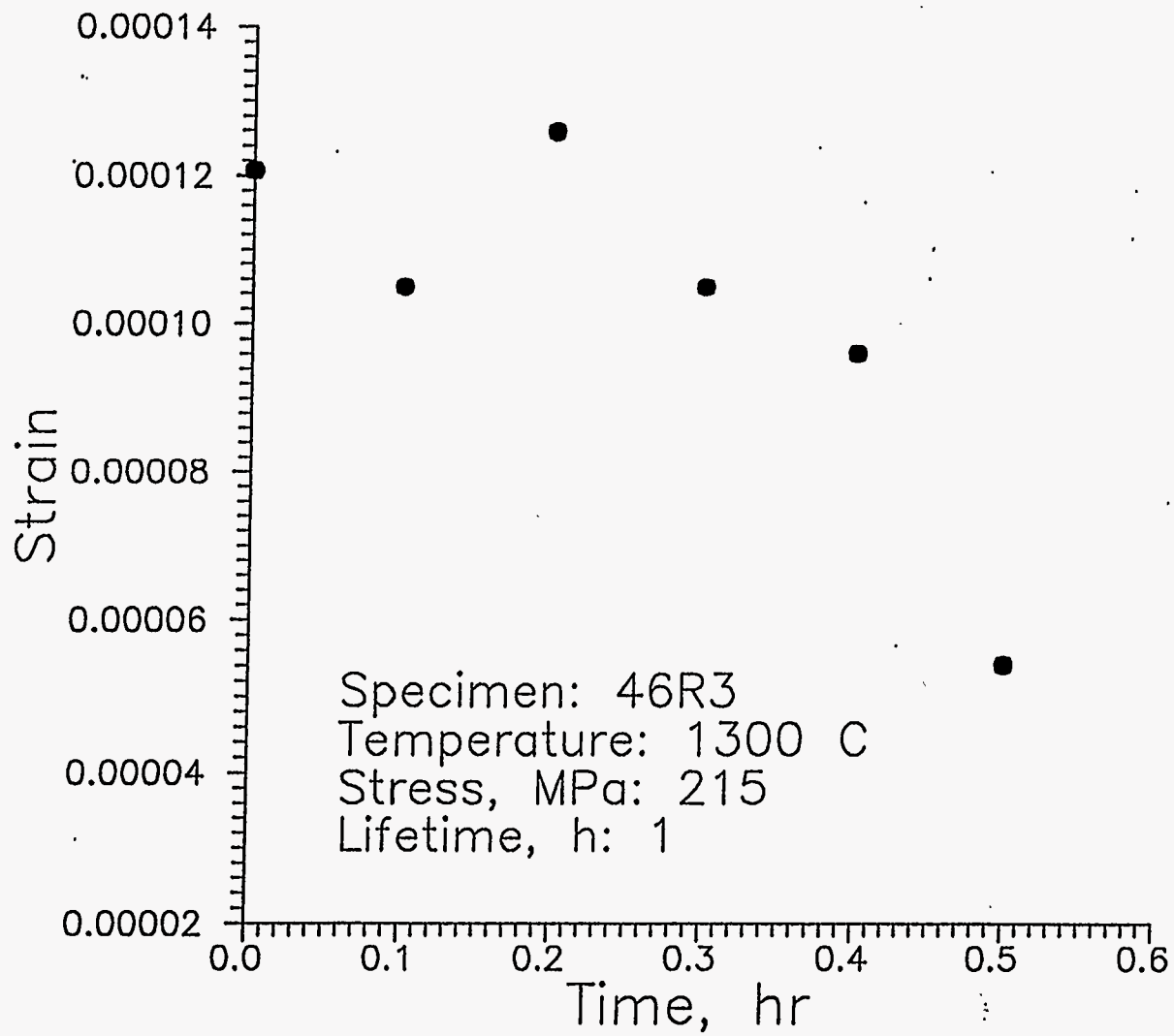
Specimen: 39r3
Temperature: 1300 C
Stress, MPa: 180
Lifetime, h: 1

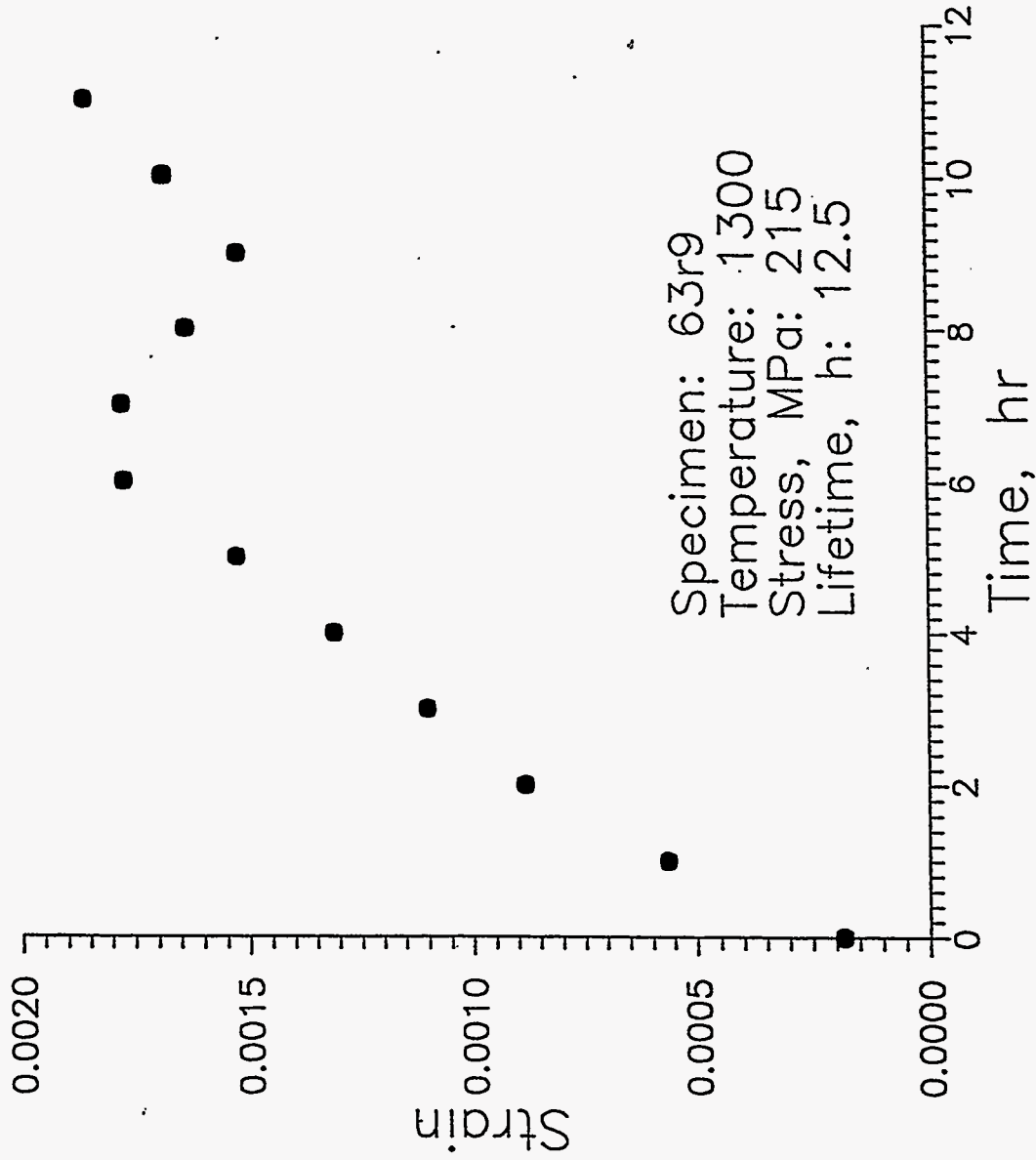


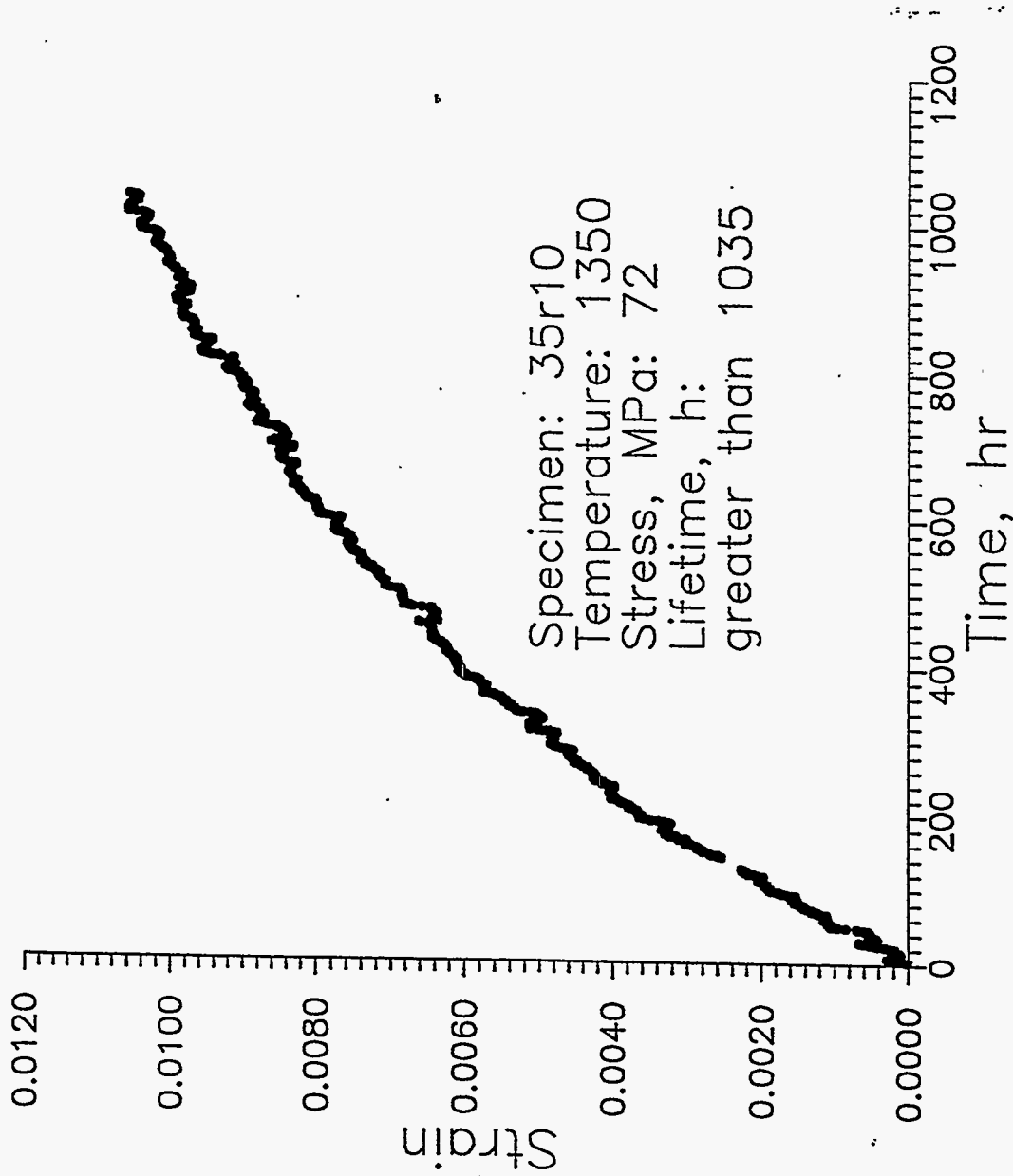


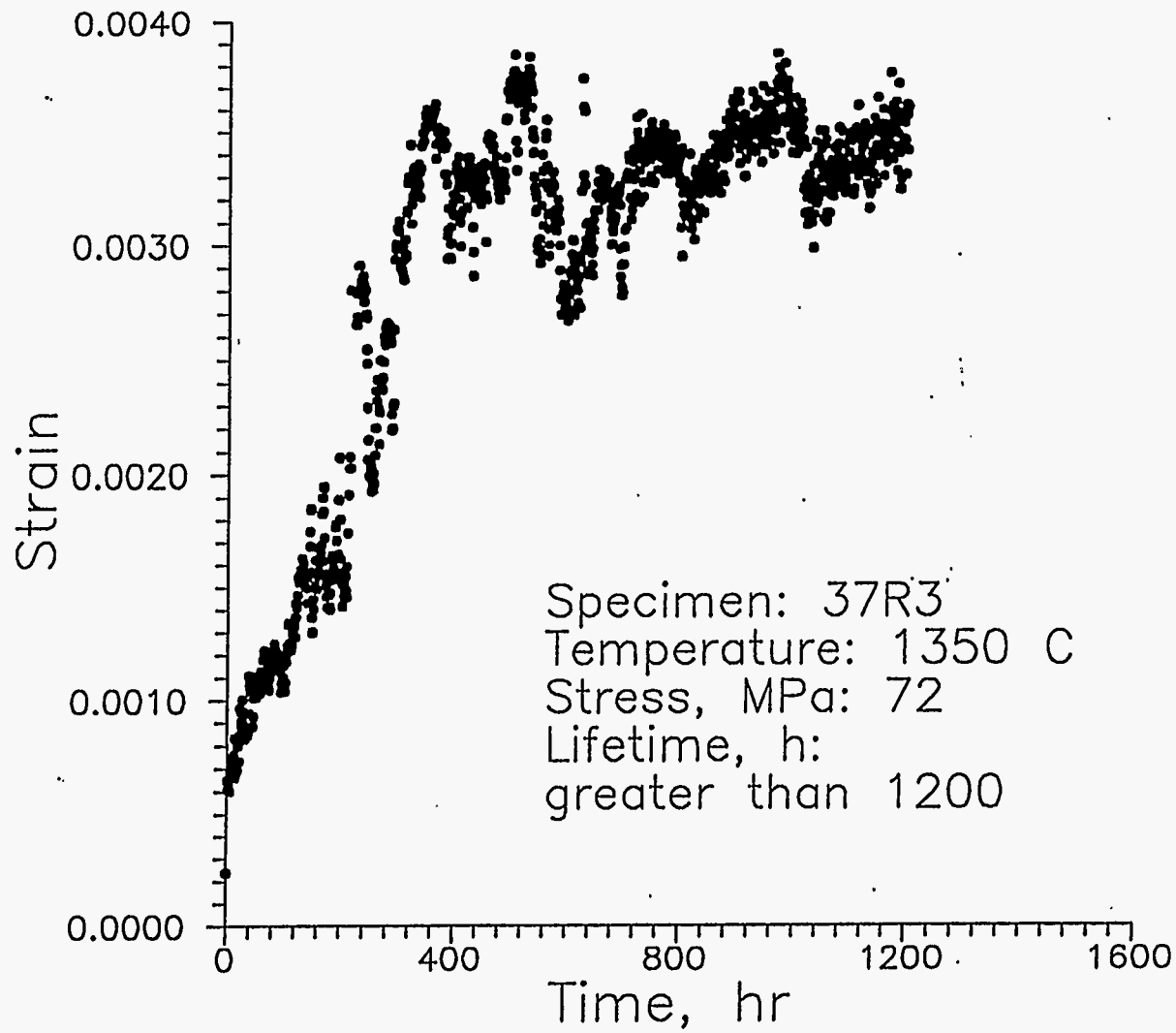
Specimen: 36R8
Temperature: 1300 C
Stress, MPa: 215
Lifetime, h: 0.25

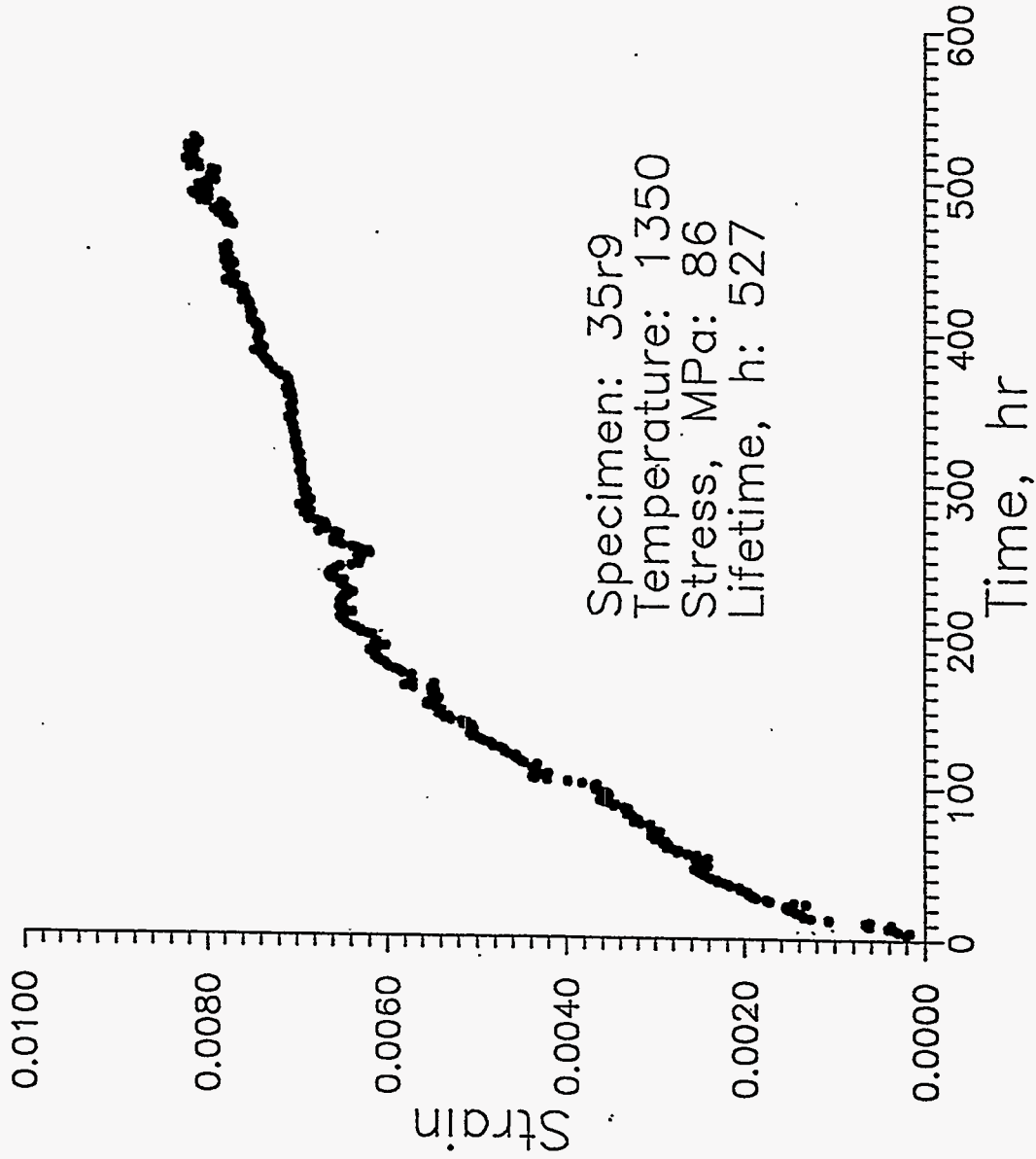


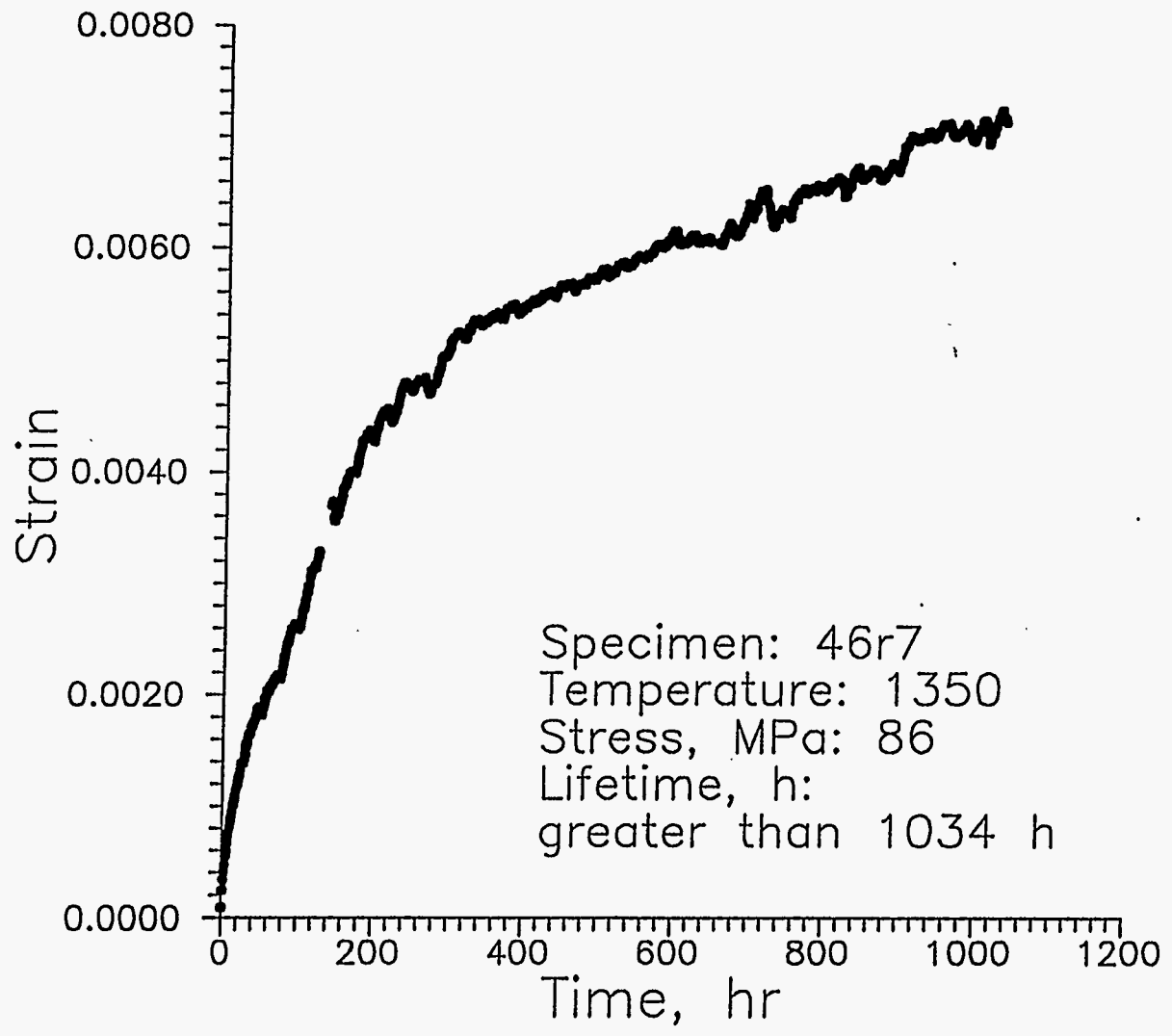


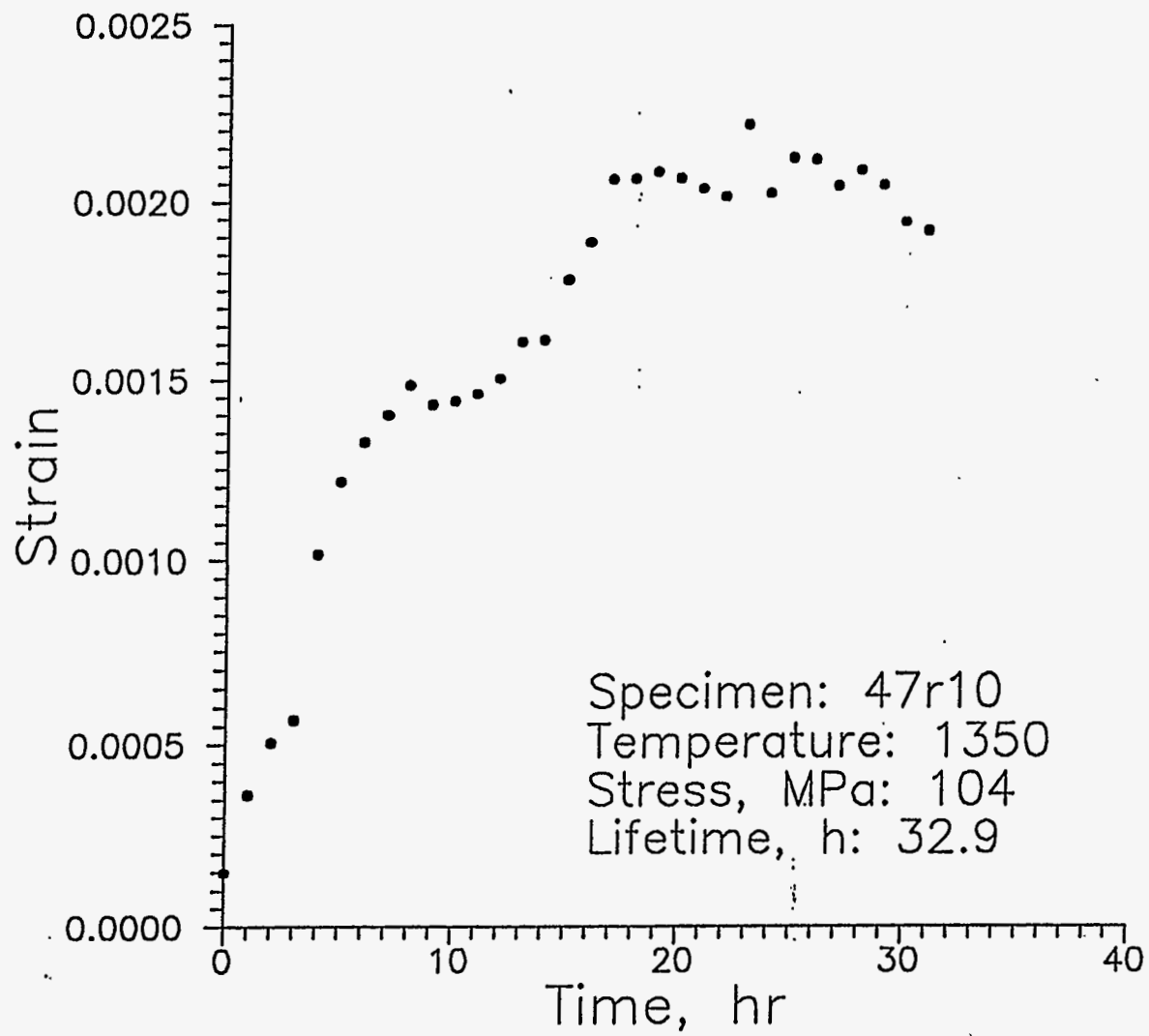


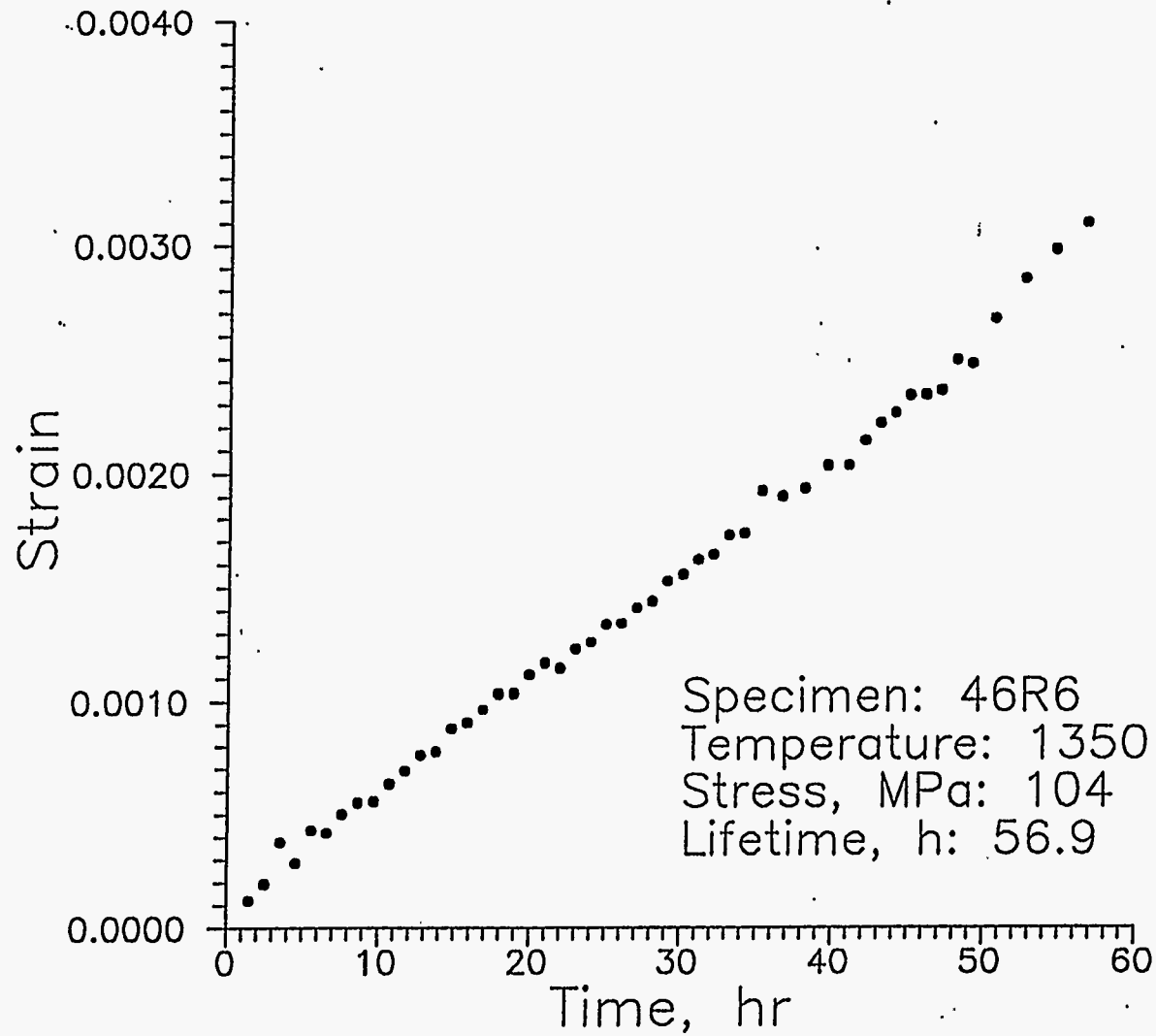


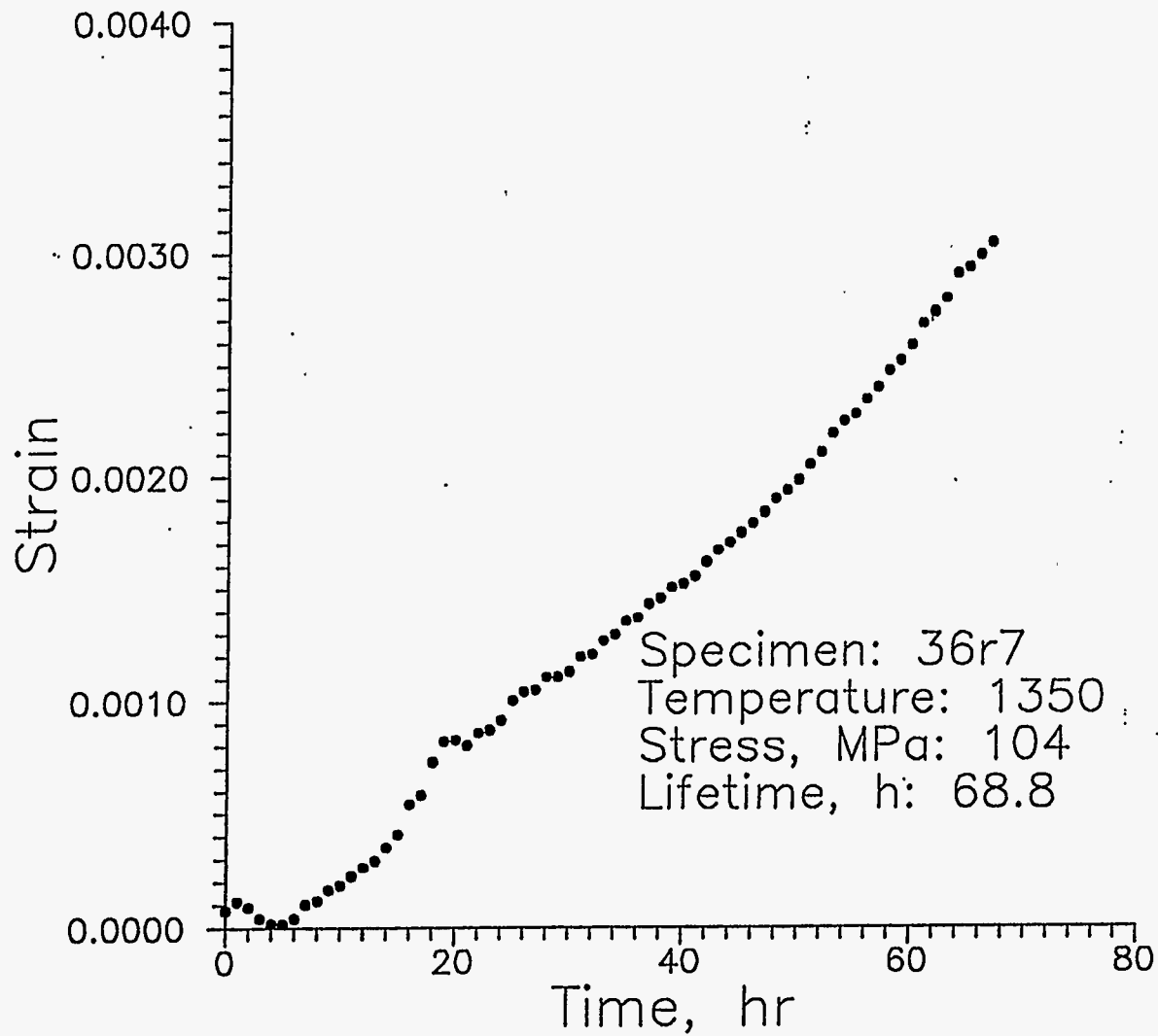


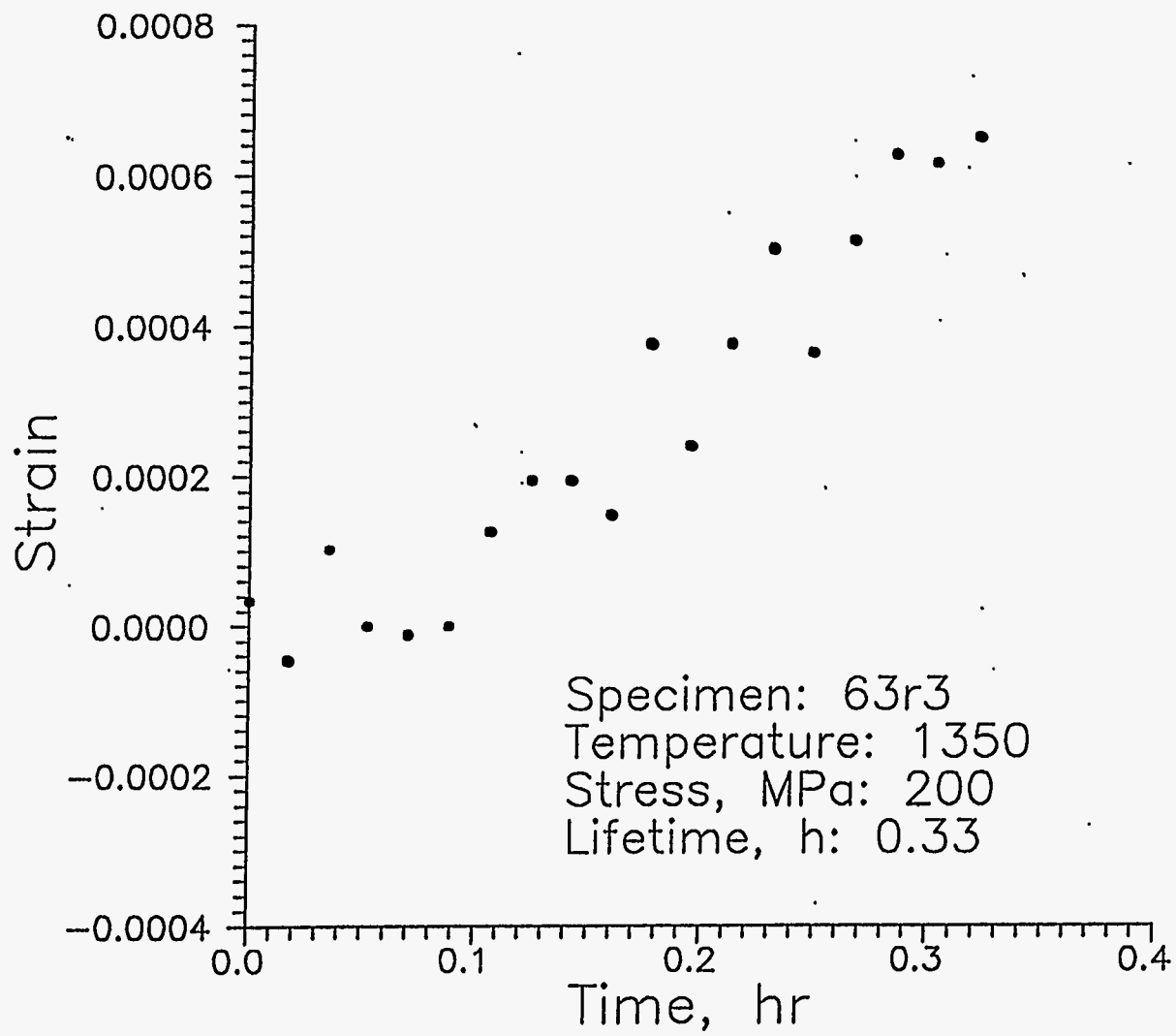


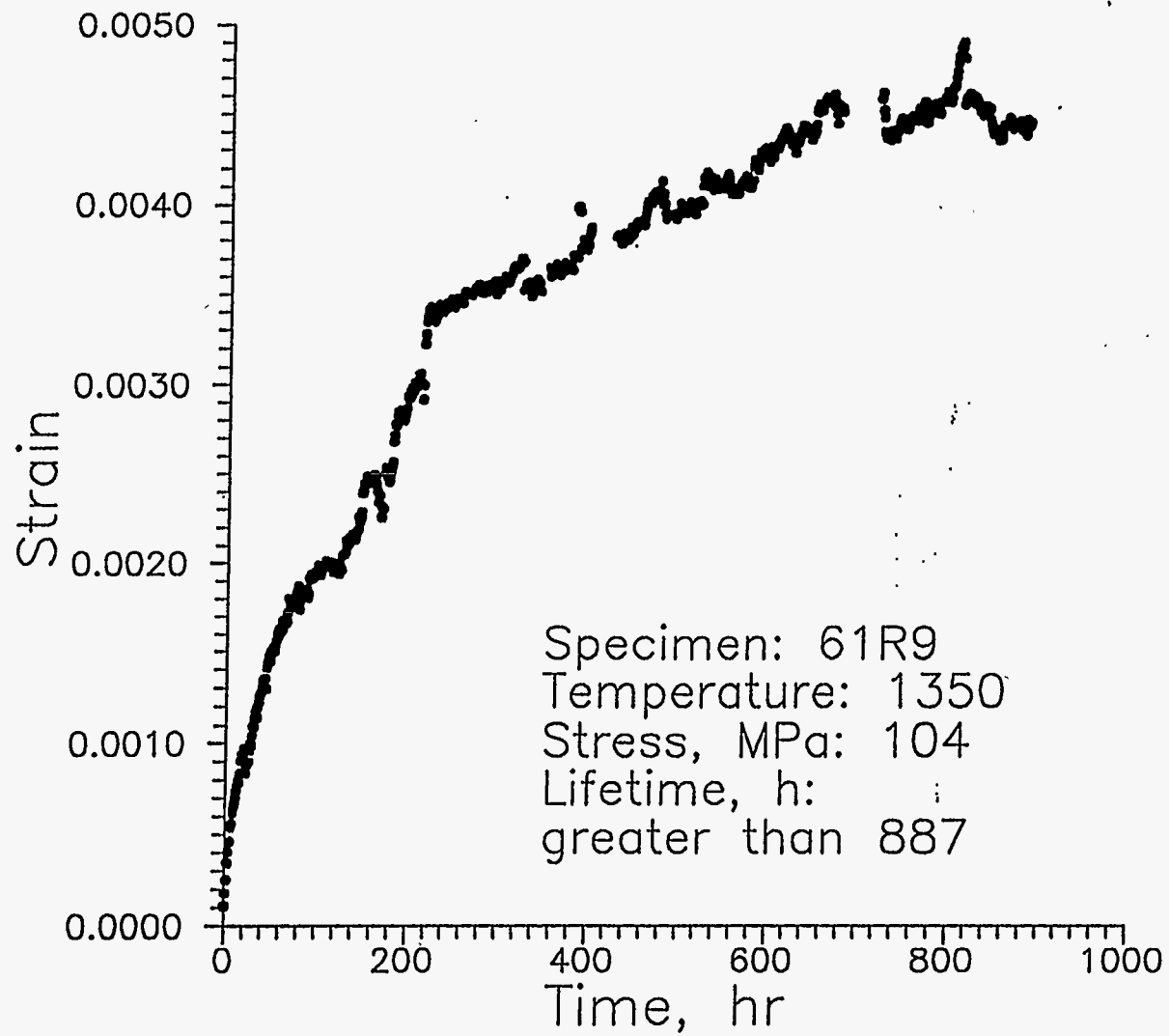


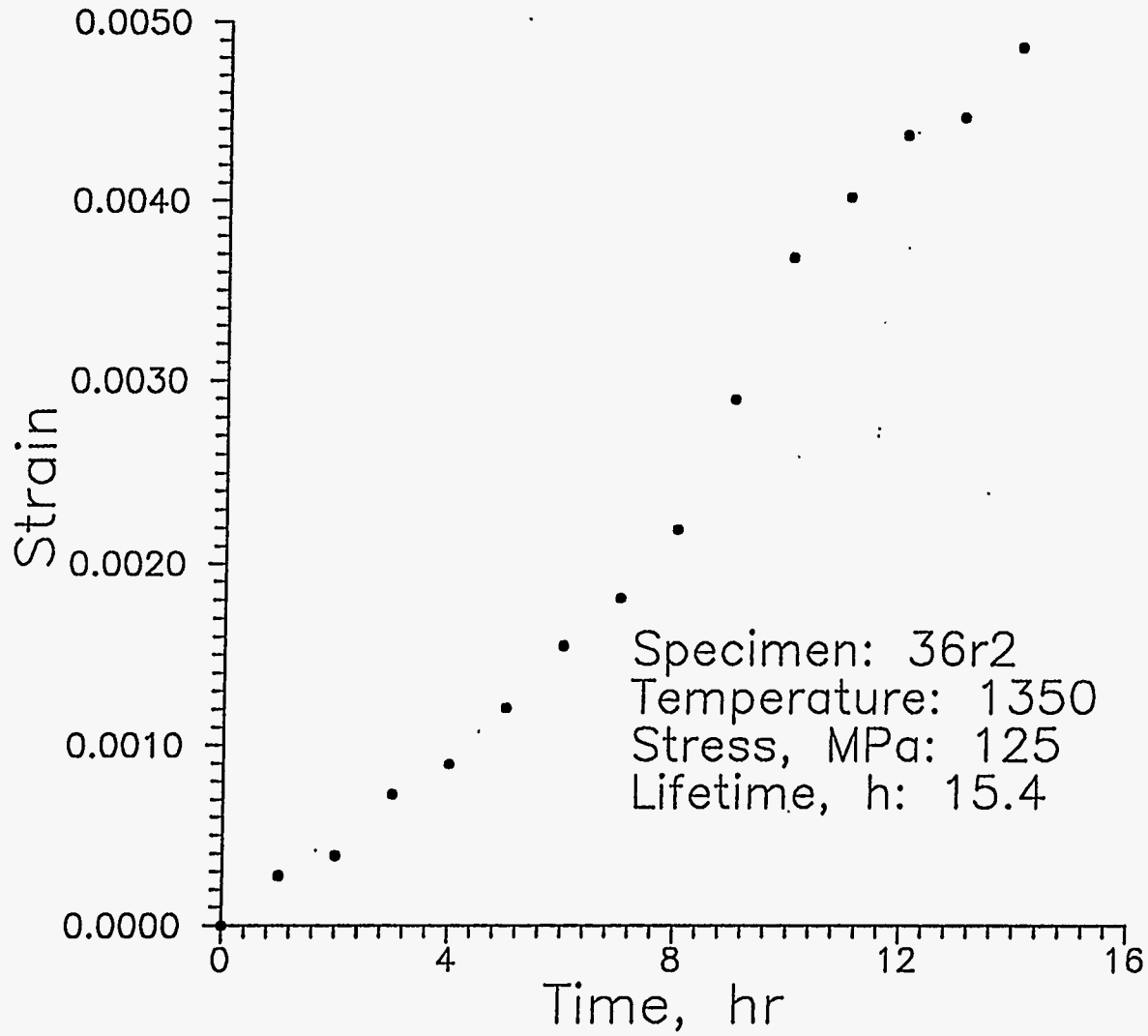


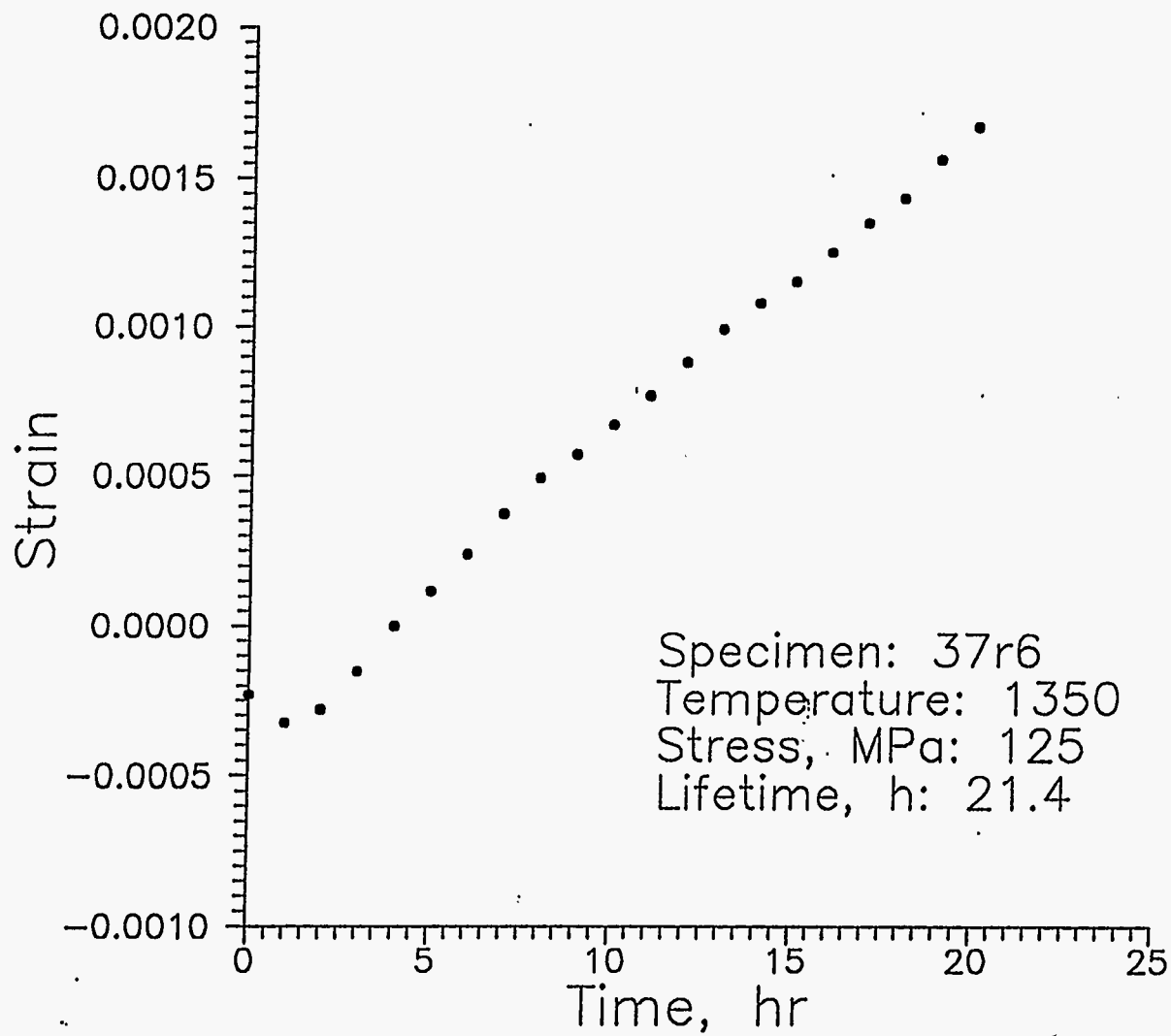


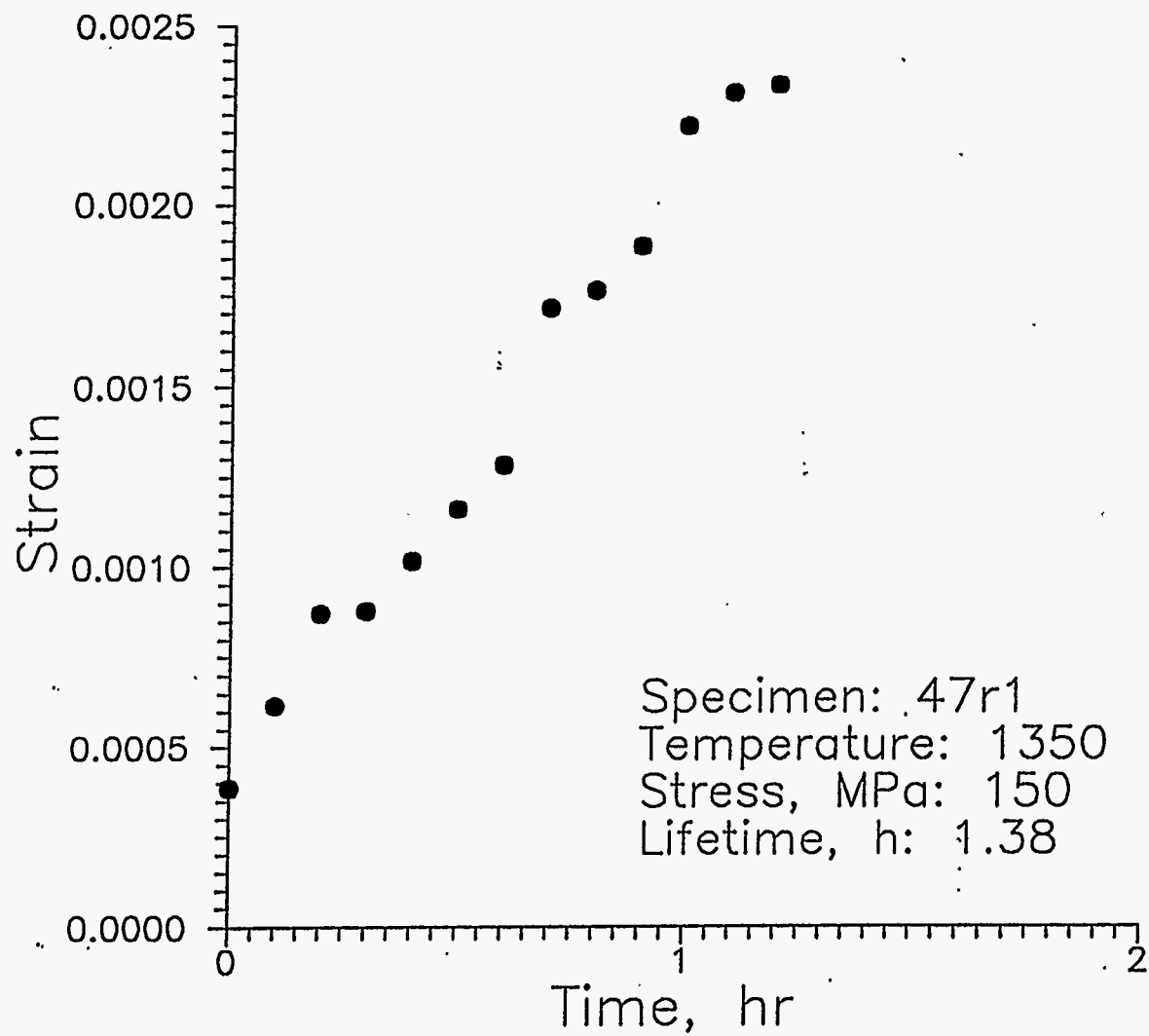


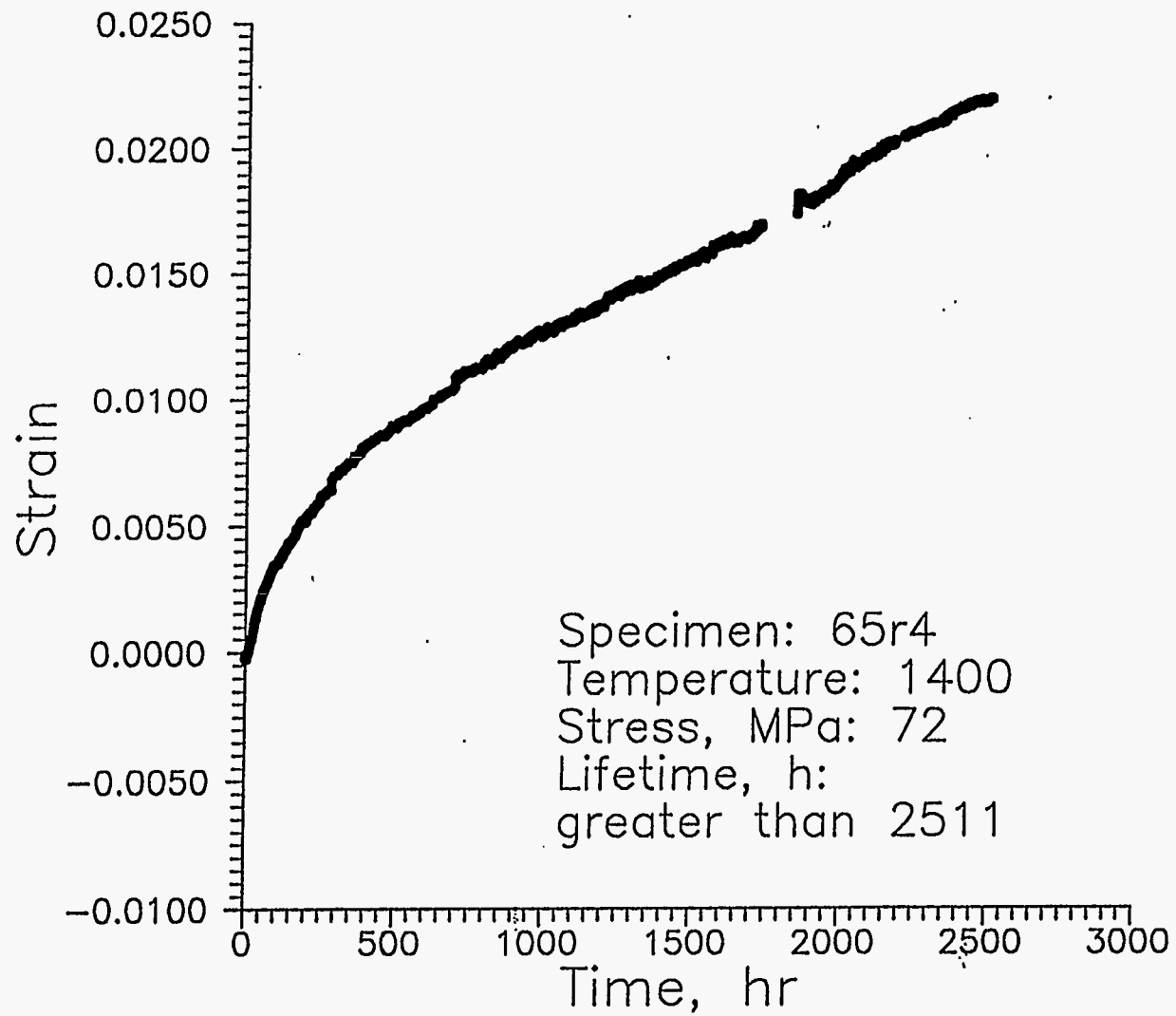


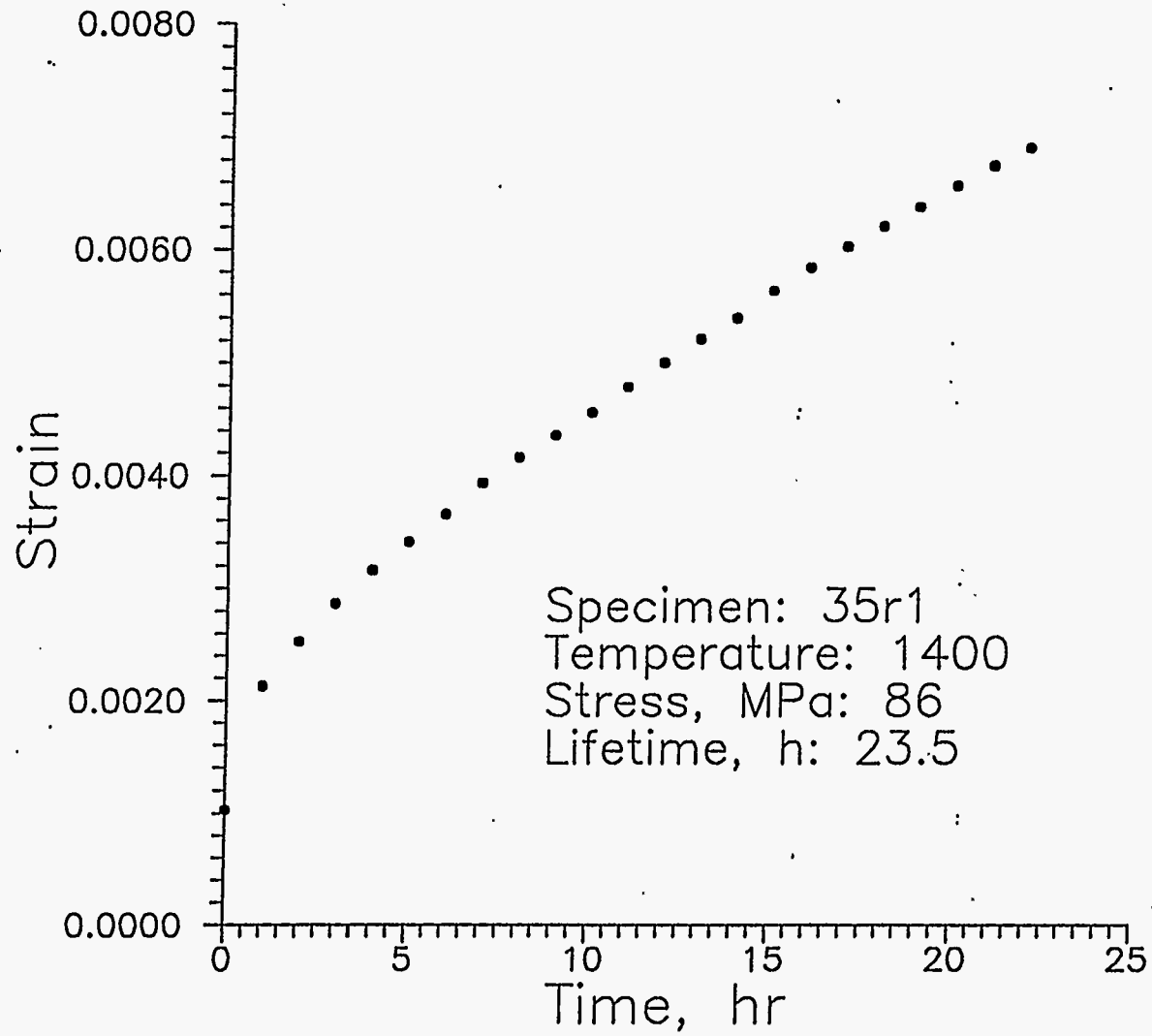


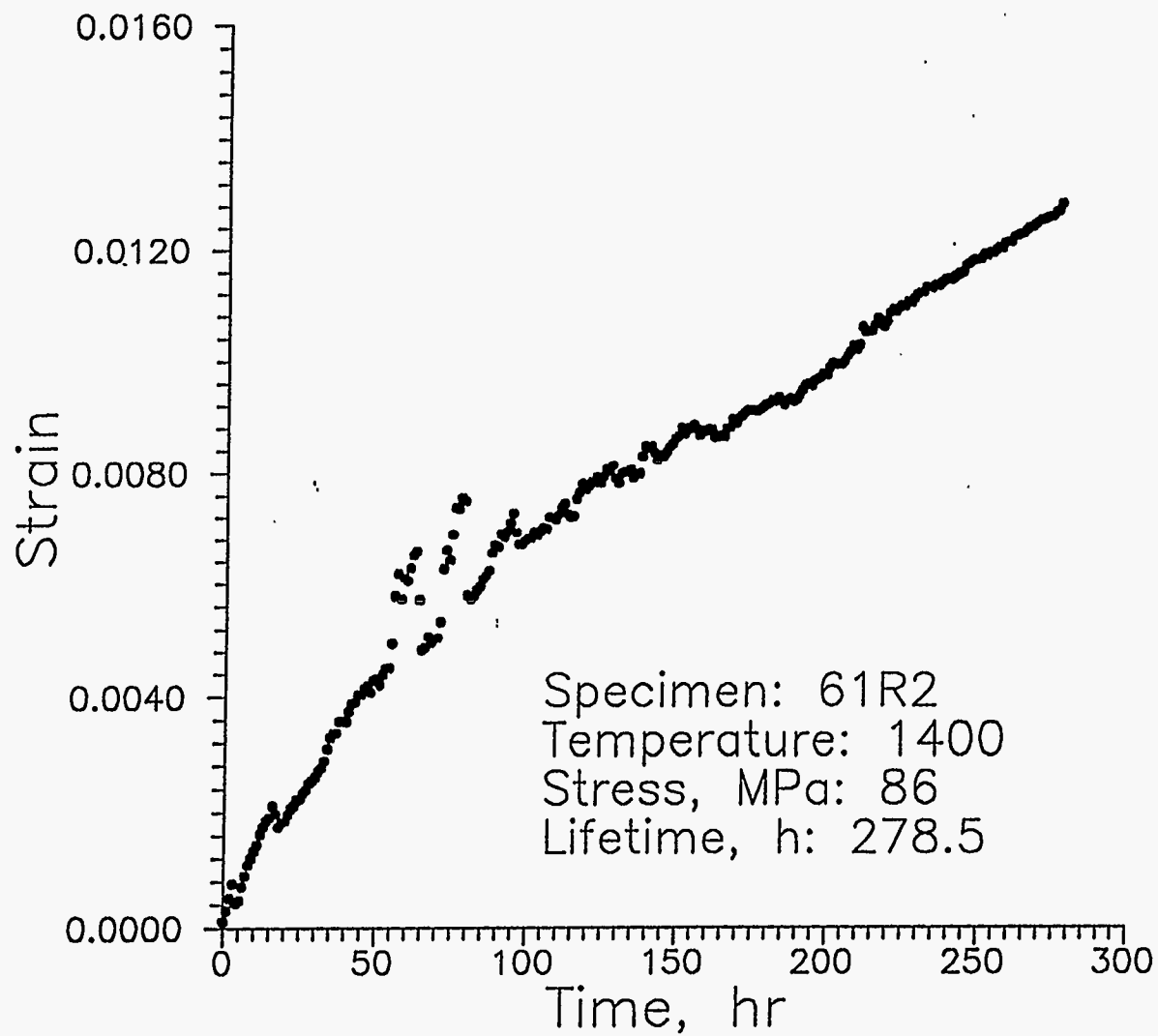


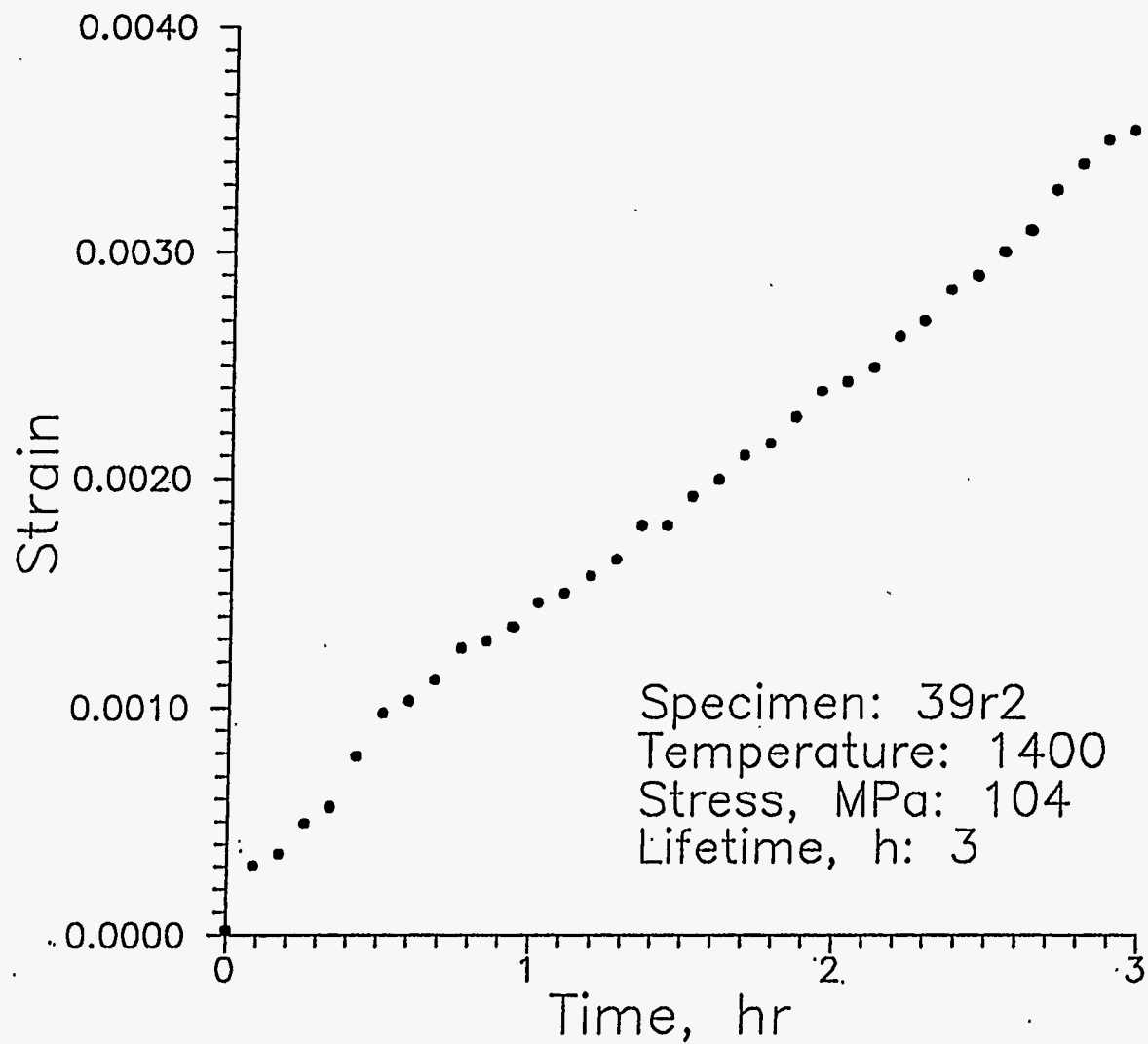


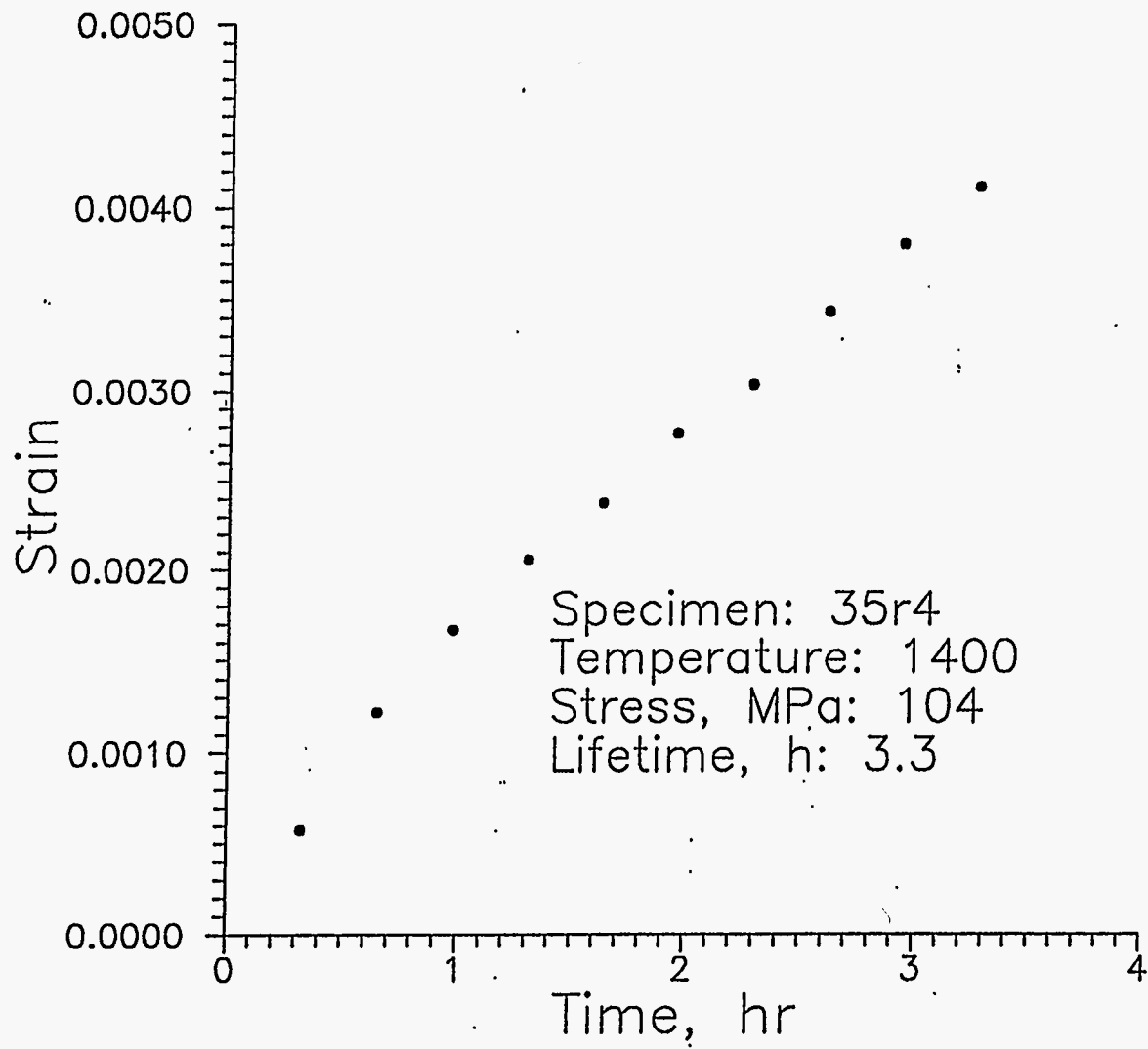


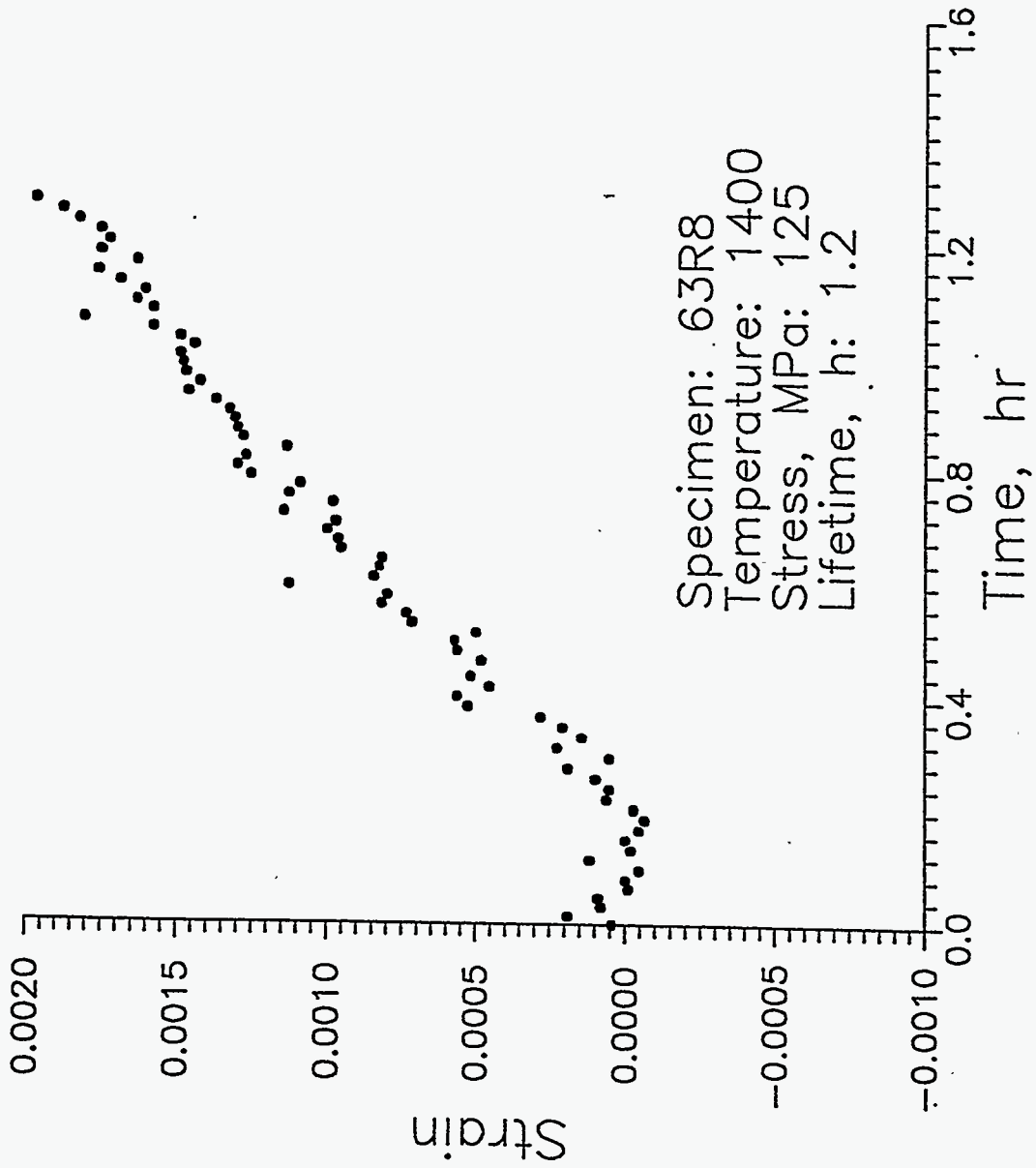


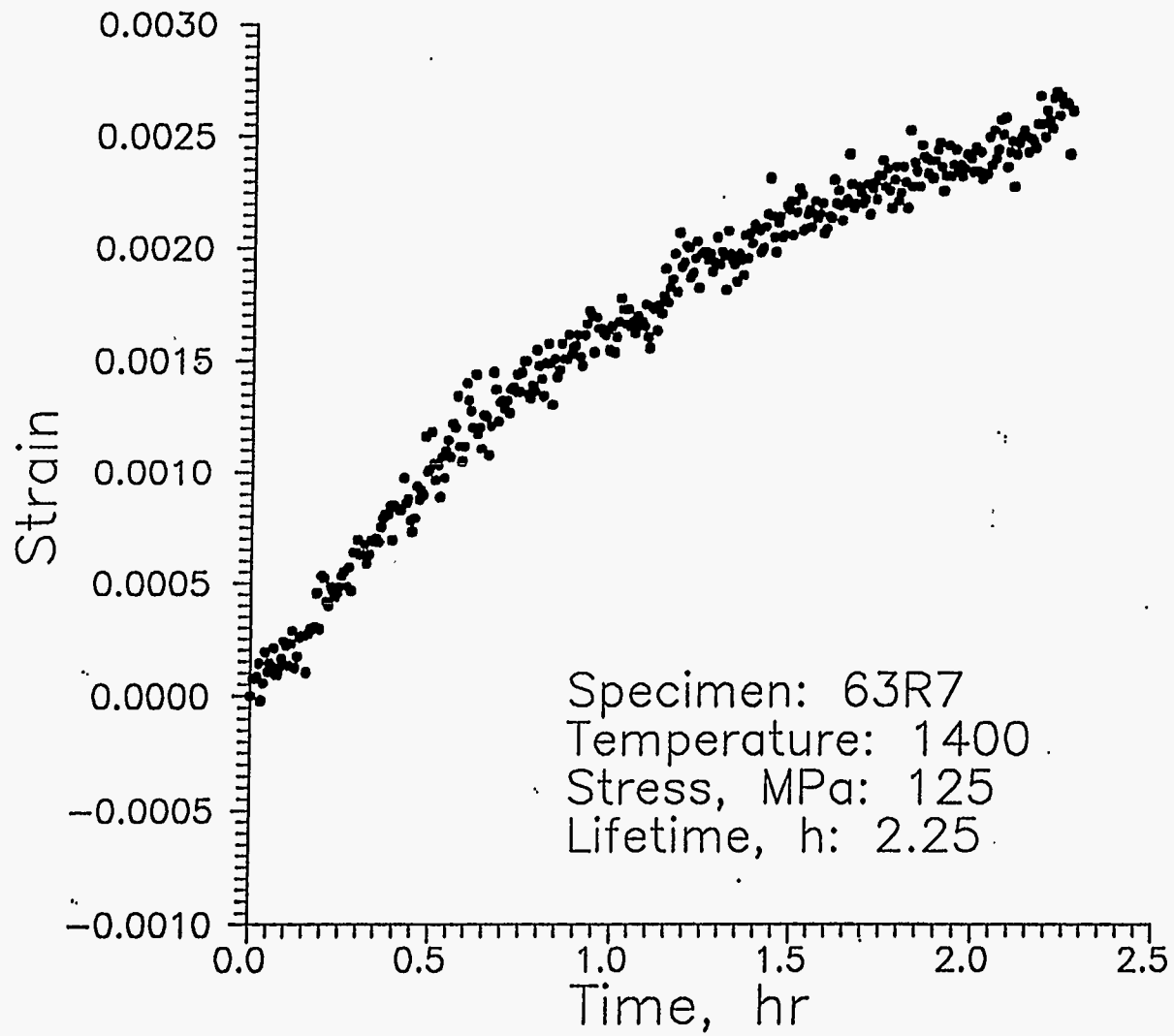






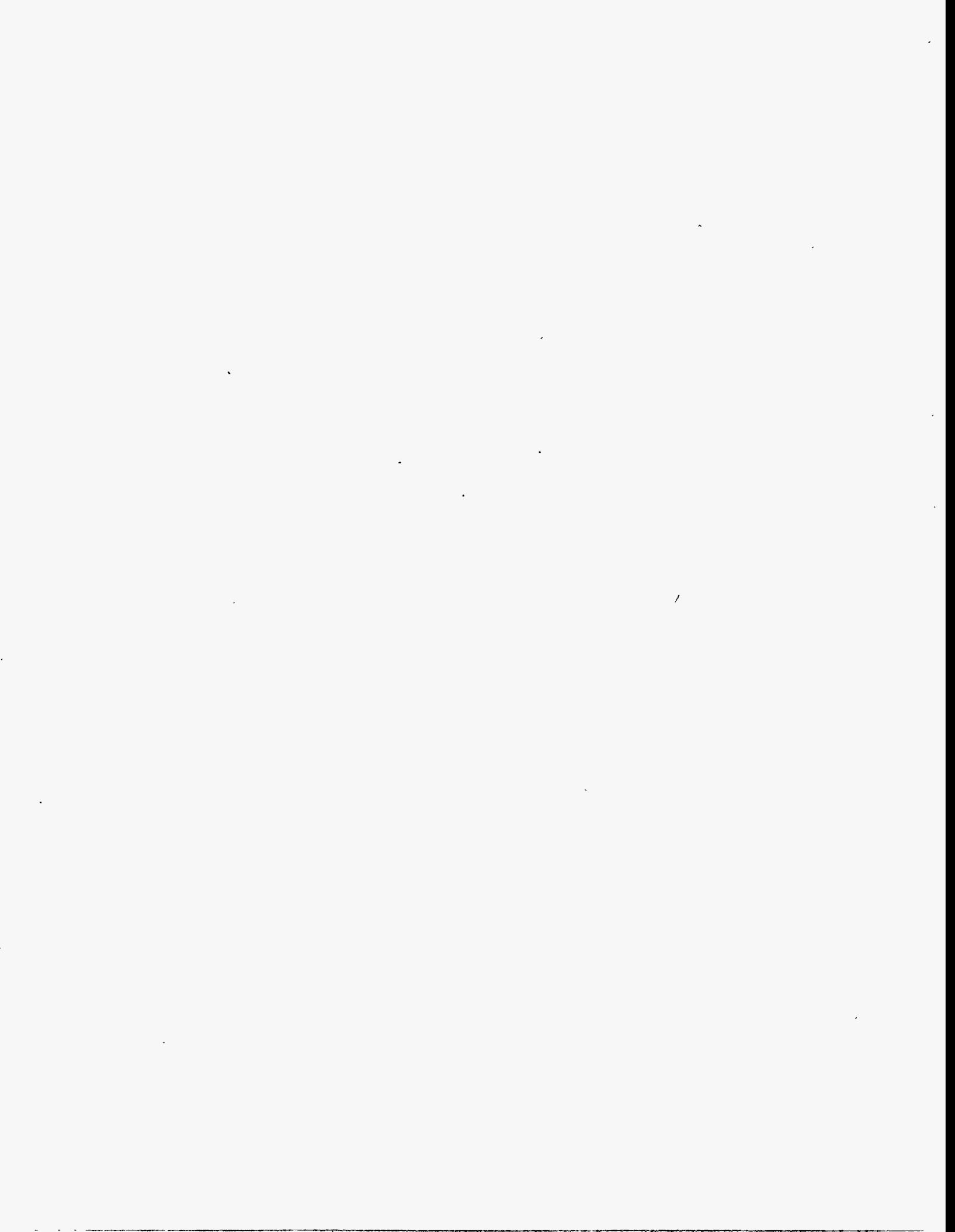






APPENDIX VII

**OXIDATION BEHAVIOR OF PY-6 SILICON NITRIDE BETWEEN
1000°C AND 1400°C IN AIR**



OXIDATION BEHAVIOR OF PY6 SILICON NITRIDE AT 1400°C (2552°F) IN AIR

TIME Hrs.	Specimen Number	Lot Number	Weight Before gm	Weight After gm	Weight Change (m), mg	Length cm	Height cm	Width cm	Surface Area (A) cm^2	m/A mg/cm^2	Oxide Layer Thickness uM	Flexural Strength		Failure Origin	Coordinates of Failure Origin (mm)	
												KSI	MPa.		X	Y
1	34.1551	Q21-19	1.9907	1.9987	8.0000	5.0922	0.3010	0.4054	7.4380	1.0756	3.6	113.84	784.94	SFC	18.9	0.2
1	34.1552	Q21-19	1.9935	1.9900	-3.5000	5.0922	0.3010	0.4054	7.4380	-0.4706	4.3	119.34	822.87	SFC	27.4	0.0
1	34.1553	Q21-19	1.9909	1.9700	-20.9000	5.0922	0.3010	0.4054	7.4380	-2.8099	0.6	106.15	731.89	SI	25.1	1.5
1	34.1554	Q21-19	2.0059	2.0050	-0.9000	5.0922	0.3010	0.4054	7.4380	-0.1210	6.8	120.99	834.24	SFC	23.3	0.2
1	34.1555	Q21-19	1.9939	1.9915	-2.4000	5.0922	0.3010	0.4054	7.4380	-0.3227	1.6	81.21	559.93	SFC	24.7	0.2
				Average	-3.9400					-0.5297	3.4	108.31	746.77			
				Std. Dev.	9.4023					1.2641	2.2	14.51	100.03			
3	34.1561	Q21-19	1.9986	1.9942	-4.4000	5.0935	0.3028	0.4044	7.4484	-0.5907	N/A	129.25	891.19	SFC	30.8	0.2
3	34.1562	Q21-19	1.9917	1.9873	-4.4000	5.0927	0.3018	0.4036	7.4279	-0.5924	2.5	122.02	841.32	SFC	16.3	3.8
3	34.1563	Q21-19	1.9894	1.9928	3.4000	5.0914	0.3035	0.4039	7.4484	0.4565	3.1	84.95	585.74	SFC	22.2	3.8
3	34.1564	Q21-19	1.9866	1.9900	3.4000	5.0919	0.3015	0.4034	7.4213	0.4581	3.2	102.86	709.24	SFC	18.2	3.8
3	34.1565	Q21-19	2.0108	2.0109	0.1000	5.0924	0.3043	0.4044	7.4637	0.0134	2.0	127.24	877.29	SFC	30.6	3.8
				Average	-0.3800					-0.0510	2.2	113.26	780.96			
				Std. Dev.	3.4965					0.4702	1.2	16.95	116.90			
6	34.1495	Q21-19	1.9956	1.9934	-2.2000	5.0947	0.3018	0.4044	7.4390	-0.2957	3.5	100.44	692.55	SFC	28.4	0.2
6	34.1496	Q21-19	1.9927	1.9999	7.2000	5.0947	0.3015	0.4046	7.4390	0.9679	2.6	111.04	765.61	SFC	24.1	3.8
6	34.1497	Q21-19	2.0158	2.0102	-5.6000	5.0924	0.3045	0.4044	7.4665	-0.7500	2.0	129.15	890.49	SF	15.3	1.0
6	34.1498	Q21-19	1.9938	1.9960	2.2000	5.0924	0.3015	0.4046	7.4357	0.2959	2.3	109.36	754.04	SFC	20.6	3.8
6	34.1499	Q21-19	1.9911	1.9933	2.2000	5.0957	0.3018	0.4044	7.4405	0.2957	3.6	97.83	674.55	II	25.2	2.1
				Average	0.7600					0.1027	2.8	109.56	755.45			
				Std. Dev.	4.3550					0.5846	0.6	11.02	75.95			
10	34.1490	Q21-19	1.9933	2.0009	7.6000	5.0932	0.3020	0.4044	7.4397	1.0216	2.1	109.94	758.05	SF	22.4	3.1
10	34.1491	Q21-19	1.9998	1.9913	-8.5000	5.0955	0.3018	0.4044	7.4401	-1.1425	1.7	102.41	706.13	SF	35.6	3.0
10	34.1492	Q21-19	1.9949	1.9914	-3.5000	5.0965	0.3010	0.4041	7.4304	-0.4710	1.8	100.78	694.90	SFC	20.7	0.8
10	34.1493	Q21-19	2.0005	2.0043	3.8000	5.0927	0.0000	0.4041	4.1161	0.9232	N/A	126.93	875.19	SFC	31.0	3.8

OXIDATION BEHAVIOR OF PY6 SILICON NITRIDE AT 1400°C (2552°F) IN AIR (Continued)

TIME Hrs.	Specimen Number	Lot Number	Weight Before gm	Weight After gm	Weight Change (m), mg	Length cm	Height cm	Width cm	Surface Area (A) cm ²	m/A mg/cm ²	Oxide Layer Thickness uM	Flexural Strength		Failure Origin	Coordinates of Failure Origin (mm)			
												KSI	MPa.		X	Y		
10	34.1494	Q21-19	2.0116	2.0115	-0.1000	5.0914	0.3058	0.4044	7.4790	-0.0134	1.2	84.53	582.80	SF	32.1	3.6		
				Average	-0.0875							0.0397	0.9				87.43	602.85
				Std. Dev.	4.4251							0.6529	0.9				48.81	283.20
50	34.1485	Q21-19	1.9894	1.9958	6.4000	5.0957	0.3028	0.4059	7.4681	0.8570	2.8	99.88	688.65					
50	34.1486	Q21-19	1.9863	1.9988	12.5000	5.0955	0.3018	0.4054	7.4511	1.6776	2.7	108.98	751.41	SF	26.7	1.2		
50	34.1487	Q21-19	1.9897	1.9905	0.8000	5.0930	0.3028	0.4054	7.4586	0.1073	2.1	104.96	723.70	SF	36.2	3.1		
50	34.1488	Q21-19	1.9852	1.9988	13.6000	5.0968	0.3025	0.4056	7.4640	1.8221	2.2	93.34	643.56	SF	31.2	3.6		
50	34.1489	Q21-19	1.9929	1.9915	-1.4000	5.0947	0.3025	0.4046	7.4501	-0.1879	2.2	100.20	690.90	SF	24.0	3.0		
				Average	6.3800							0.8552	2.4				101.47	699.64
				Std. Dev.	6.0208							0.8073	0.3				5.27	36.33
100	34.1480	Q21-19	1.9977	1.9987	1.0000	5.0998	0.3035	0.4064	7.4877	0.1336	2.6	109.34	753.89	SF	22.6	0.6		
100	34.1481	Q21-19	1.9865	1.9875	1.0000	5.0945	0.3028	0.4044	7.4498	0.1342	3.1	94.35	650.56	SFC	24.2	3.8		
100	34.1482	Q21-19	2.0043	2.0053	1.0000	5.0942	0.3048	0.4056	7.4855	0.1336	3.5	109.36	754.06	SF	32.8	0.6		
100	34.1483	Q21-19	1.9853	1.9908	5.5000	5.0950	0.3025	0.4046	7.4505	0.7382	3.8	104.13	717.98	SF	16.4	2.8		
100	34.1484	Q21-19	1.9897	1.9907	1.0000	5.0985	0.3020	0.4049	7.4527	0.1342	3.0	78.50	541.26	SF	19.7	0.5		
				Average	1.9000							0.2548	3.2				99.14	683.55
				Std. Dev.	1.8000							0.2417	0.4				11.68	80.55
500	34.1556	Q21-19	1.9883	1.9929	4.6000	5.1008	0.3053	0.4069	7.5142	0.6122	4.0	90.21	622.03	SF	23.8	3.1		
500	34.1557	Q21-19	2.0017	2.0030	1.3000	5.0983	0.3061	0.4069	7.5190	0.1729	6.8	100.64	693.88	SF	27.2	1.5		
500	34.1558	Q21-19	1.9967	1.9912	-5.5000	5.1024	0.3053	0.4069	7.5164	-0.7317	5.0	88.25	608.47	SF	29.7	1.2		
500	34.1559	Q21-19	2.0038	1.9984	-5.4000	5.1011	0.3071	0.4064	7.5287	-0.7173	4.0	86.06	593.40	SFC	32.9	3.8		
500	34.1560	Q21-19	1.9988	1.9949	-3.9000	5.0957	0.3023	0.4051	7.4543	-0.5232	4.0	96.62	666.21	SF	24.2	2.2		
				Average	-1.7800							-0.2374	4.8				92.36	636.80
				Std. Dev.	4.0405							0.5378	1.1				5.44	37.49

OXIDATION BEHAVIOR OF PY6 SILICON NITRIDE AT 1371°C (2500°F) IN AIR

TIME Hrs.	Specimen Number	Lot Number	Weight Before gm	Weight After gm	Weight Change (m), mg	Length cm	Height cm	Width cm	Surface Area (A) cm.^2	m/A mg/cm^2	Oxide Layer Thickness uM	Flexural Strength		Failure Origin	Coordinates of Failure Origin (mm)	
												KSI	MPa.		X	Y
100	34.1571	Q21-19	1.9950	1.9963	1.3000	5.0897	0.3012	0.4023	7.3959	0.1758	2.6	95.42	657.9	SF	31.0	3.5
100	34.1572	Q21-19	1.9970	1.9983	1.3000	5.0950	0.3012	0.4021	7.3895	0.1759	2.1	79.57	548.6	SFC	24.4	3.8
100	34.1573	Q21-19	1.9851	1.9855	0.4000	5.0937	0.2987	0.4023	7.4128	0.0540	2.6	101.90	702.6	SF	20.5	3.4
100	34.1574	Q21-19	1.9970	1.9981	1.1000	5.0945	0.3010	0.4031	7.3860	0.1489	2.0	98.30	677.8	SF	23.0	3.5
100	34.1575	Q21-19	1.9822	1.9813	-0.9000	5.0932	0.3000	0.4023	7.4149	-0.1214	2.0	88.74	611.9	SFC	17.0	3.8
100	34.2067	Q21-90-64	1.9936	1.9938	0.2000	5.0955	0.2995	0.4026	7.3854	0.0271	2.0	104.54	720.8	SF	20.7	3.4
100	34.2068	Q21-90-64	1.9917	1.9922	0.5000	5.0965	0.2997	0.4031	7.3868	0.0677	2.3	97.81	674.4	SF	26.2	3.5
100	34.2070	Q21-90-64	1.9838	1.9840	0.2000	5.0914	0.2992	0.4018	7.3797	0.0271	2.8	118.36	816.1	SFC	30.6	3.8
				Average	0.5125					0.0694	2.3	98.08	676.3			
				Std. Dev.	0.6882					0.0930	0.3	10.63	73.3			

OXIDATION BEHAVIOR OF PY6 SILICON NITRIDE AT 1300°C (2372°F) IN AIR

TIME Hrs.	Specimen Number	Lot Number	Weight Before gm	Weight After gm	Weight Change (m), mg	Length cm	Height cm	Width cm	Surface Area (A) cm.^2	m/A mg/cm^2	Oxide Layer Thickness uM	Flexural Strength		Failure Origin	Coordinates of Failure Origin (mm)	
												KSI	MPa.		X	Y
100	34.1476	Q21-19	1.9877	1.9898	2.1000	5.0942	0.3030	0.4051	7.4605	0.2815	110.57	762.35	3	SF	18.8	1.7
100	34.1477	Q21-19	1.9832	1.9853	2.1000	5.0957	0.3028	0.4041	7.4489	0.2819	103.04	710.49	2	SFC	31.8	0.0
100	34.1478	Q21-19	2.0043	2.0053	1.0000	5.0897	0.3066	0.4054	7.4958	0.1334	93.14	642.21	2.5	SF	20.0	3.2
100	34.1479	Q21-19	2.0020	2.0041	2.1000	5.0927	0.3043	0.4049	7.4696	0.2811	110.88	764.50	2.3	SF	23.1	1.4
100	34.1525	Q21-19	2.0001	2.0055	5.4000	5.0919	0.3137	0.4046	7.5691	0.7134	97.68	673.49	3	SF	15.1	3.7
				Average	2.5400					0.3383	103.1	710.61	2.6			
				Std. Dev.	1.4921					0.1962	7.00	48.24	0.4			
500	34.1844	Q21-90-42	1.9831	1.9713	-11.8000	5.0889	0.3023	0.3988	7.3761	-1.5998	75.50	520.55	2.8	SF	17.9	0.5
500	34.1845	Q21-90-42	1.9837	1.9837	0.0000	5.0864	0.3023	0.3988	7.3725	0.0000	85.03	586.31	3	SF	30.3	1.1
500	34.1846	Q21-90-42	1.9713	1.9834	12.1000	5.0864	0.3010	0.3975	7.3449	1.6474	80.35	554.03	3	SF	23.6	3.4
500	34.1847	Q21-90-42	1.9687	1.9691	0.4000	5.0876	0.3005	0.3973	7.3384	0.0545	84.02	579.35	2.5	SF	30.3	0.3
500	34.1849	Q21-90-42	1.9812	1.9814	0.2000	5.0864	0.3010	0.3988	7.3586	0.0272	49.57	341.80	4	SI	28.8	1.2
				Average	0.1800					0.0259	74.90	516.41	3.1			
				Std. Dev.	7.5589					1.0270	13.10	90.30	0.5			

OXIDATION BEHAVIOR OF PY6 SILICON NITRIDE AT 1260°C (2300°F) IN AIR

TIME Hrs.	Specimen Number	Lot Number	Weight Before gm	Weight After gm	Weight Change (m), mg	Length cm	Height cm	Width cm	Surface Area (A) cm.^2	m/A mg/cm^2	Oxide Layer		Flexural Strength		Failure Origin	Coordinates of Failure Origin (mm)	
											Thickness uM		KSI	MPa.		X	Y
100	34.1576	Q21-19	2.0000	2.0011	1.1000	5.0891	0.3000	0.4028	7.3952	0.1487	92.37	636.89	1.9	SFC	26.3	3.8	
100	34.1577	Q21-19	1.9863	2.0040	17.7000	5.0957	0.2990	0.4026	7.3905	2.3950	79.07	545.2	2.6	SFC	19.4	3.9	
100	34.1578	Q21-19	1.9992	1.9849	-14.3000	5.0932	0.3012	0.4026	7.4121	-1.9293	83.70	577.14	2.7	SF	28.6	1.3	
100	34.1579	Q21-19	1.9812	1.9831	1.9000	5.0919	0.2990	0.4023	7.3825	0.2574	92.04	634.61	2.1	SFC	20.3	4.0	
100	34.1595	Q21-19	2.0033	1.9815	-21.8000	5.0922	0.3015	0.4026	7.4135	-2.9406	83.56	576.17	2.1	SF	25.3	3.6	
100	34.1826	Q21-90-42	1.9788	1.9787	-0.1000	5.0914	0.3023	0.3988	7.3797	-0.0136	101.58	700.37	2.0	SF	31.0	0.5	
100	34.1827	Q21-90-42	1.9804	1.9804	0.0000	5.0876	0.3023	0.3988	7.3743	0.0000	117.46	809.92	1.5	SF	32.7	3.0	
100	34.1843	Q21-90-42	1.9829	1.9828	-0.1000	5.0876	0.3023	0.3988	7.3743	-0.0136	109.06	751.96	1.0	SF	17.4	1.9	
				Average	-1.9500					-0.2620	94.86	654.03	2.0				
				Std. Dev.	-2.3857					-0.3207	95.21	656.48	2.0				

OXIDATION BEHAVIOR OF PY6 SILICON NITRIDE AT 1200°C (2192°F) IN AIR

TIME Hrs.	Specimen Number	Lot Number	Weight Before gm	Weight After gm	Weight Change (m), mg	Length cm	Height cm	Width cm	Surface Area (A) cm.^2	m/A mg/cm^2	Oxide Layer Thickness uM	Flexural Strength		Fallure Origin	Coordinates of Fallure Origin (mm)	
												KSI	MPa.		X	Y
1	34.2056	Q21-90-64	1.9848	1.9851	0.3000	5.0813	0.2997	0.4013	7.3649	0.0407	91.31	629.56	0.8	SF	16.0	0.7
1	34.2057	Q21-90-64	1.9868	1.9870	0.2000	5.0838	0.2997	0.4013	7.3685	0.0271	113.48	782.47	1.0	SFC	32.0	0.2
1	34.2058	Q21-90-64	1.9838	1.9835	-0.3000	5.0876	0.2997	0.4013	7.3738	-0.0407	117.49	810.06	0.4	SF	16.3	1.6
1	34.2059	Q21-90-64	1.9835	1.9836	0.1000	5.0800	0.2997	0.4013	7.3631	0.0136	110.83	764.17	0.0	SF	22.0	0.6
1	34.2060	Q21-90-64	1.9839	1.9842	0.3000	5.0864	0.2997	0.4013	7.3720	0.0407	101.15	697.40	0.5	SFC	25.3	3.9
				Average	0.1200					0.0163	106.85	736.73	0.5			
				Std. Dev.	0.2227					0.0302	9.46	65.20	0.3			
3	34.2051	Q21-90-64	1.9879	1.9883	0.4000	5.0800	0.2985	0.4026	7.3629	0.0543	96.33	664.20	1.0	SFC	30.8	0.0
3	34.2052	Q21-90-64	1.9915	1.9918	0.3000	5.0800	0.2997	0.4026	7.3768	0.0407	91.08	627.97	2.0	SF	30.8	0.8
3	34.2053	Q21-90-64	1.9860	1.9861	0.1000	5.0800	0.2985	0.4013	7.3492	0.0136	100.01	689.54	1.0	SF	32.2	2.2
3	34.2054	Q21-90-64	1.9858	1.9858	0.0000	5.0825	0.2985	0.4013	7.3528	0.0000	75.18	518.36	1.3	SF	34.8	1.0
3	34.2055	Q21-90-64	1.9883	1.9883	0.0000	5.0800	0.2985	0.4013	7.3492	0.0000	92.71	639.21	1.3	SF	25.0	0.8
				Average	0.1600					0.0217	91.06	627.86	1.3			
				Std. Dev.	0.1625					0.0221	8.52	58.73	0.4			
6	34.2046	Q21-90-64	1.9843	1.9848	0.5000	5.0800	0.3010	0.4013	7.3771	0.0678	68.75	474.02	0.0	SF	17.4	1.3
6	34.2047	Q21-90-64	1.9865	1.9870	0.5000	5.0838	0.3010	0.4026	7.3961	0.0676	69.69	480.52	0.5	SF	26.2	1.3
6	34.2048	Q21-90-64	1.9926	1.9929	0.3000	5.0800	0.3010	0.4039	7.4044	0.0405	71.50	493.00	1.0	SF	35.5	0.4
6	34.2049	Q21-90-64	1.9903	1.9903	0.0000	5.0825	0.3010	0.4039	7.4080	0.0000	77.13	531.83	0.7	SF	29.7	0.6
6	34.2050	Q21-90-64	1.9904	1.9910	0.6000	5.0851	0.3023	0.4026	7.4118	0.0810	61.15	421.64	1.1	SF	34.4	2.2
				Average	0.3800					0.0514	69.64	480.20	0.7			
				Std. Dev.	0.2135					0.0289	5.15	35.49	0.4			
10	34.2041	Q21-90-64	1.9911	1.9912	0.1000	5.0838	0.2997	0.4026	7.3821	0.0135	69.65	480.21	1.0	SF	16.0	0.6
10	34.2042	Q21-90-64	1.9914	1.9914	0.0000	5.0800	0.3010	0.4039	7.4044	0.0000	75.64	521.54	0.8	SF	25.1	0.3
10	34.2043	Q21-90-64	1.9944	1.9945	0.1000	5.0800	0.3023	0.4026	7.4046	0.0135	77.93	537.35	0.8	SF	24.3	1.2
10	34.2044	Q21-90-64	1.9952	1.9952	0.0000	5.0800	0.3010	0.4026	7.3907	0.0000	88.52	610.35	0.9	SF	22.0	3.6

OXIDATION BEHAVIOR OF PY6 SILICON NITRIDE AT 1200°C (2192°F) IN AIR (Continued)

TIME Hrs.	Specimen Number	Lot Number	Weight Before gm	Weight After gm	Weight Change (m), mg	Length cm	Height cm	Width cm	Surface Area (A) cm.^2	m/A mg/cm^2	Oxide Layer Thickness uM	Flexural Strength		Failure Origin	Coordinates of Failure Origin (mm)			
												KSI	MPa.		X	Y		
10	34.2045	Q21-90-64	1.9898	1.9900	0.2000	5.0825	0.2997	0.4026	7.3804	0.0271	80.22	553.15	0.5	SF	14.7	1.7		
				Average	0.0500							0.0068	49.00				386.09	0.7
				Std. Dev.	0.0707							0.0096	38.26				246.81	0.3
50	34.1736	Q21-90-42	1.9913	1.9915	0.2000	5.0864	0.3023	0.4001	7.3862	0.0271	112.31	774.39	1.1	SF	24.3	3.2		
50	34.1738	Q21-90-42	1.9892	1.9892	0.0000	5.0876	0.3023	0.4001	7.3880	0.0000	100.83	695.20	1.6	SFC	28.7	0.0		
50	34.1739	Q21-90-42	1.9914	1.9916	0.2000	5.0876	0.3010	0.4001	7.3741	0.0271	72.03	496.67	1.7	SFC	27.8	0.2		
50	34.1740	Q21-90-42	1.9713	1.9713	0.0000	5.0571	0.3010	0.4001	7.3313	0.0000	94.30	650.20	2.0	SF	21.6	1.4		
50	34.1741	Q21-90-42	1.9906	1.9905	-0.1000	5.0902	0.3010	0.4013	7.3913	-0.0135	96.80	667.47	0.8	SF	18.6	2.3		
				Average	0.0600							0.0081	95.26				656.79	1.4
				Std. Dev.	0.1200							0.0163	13.15				90.67	0.4
100	34.1566	Q21-19	1.9907	1.9907	0.0000	5.0930	0.3010	0.4041	7.4254	0.0000	115.60	797.05	N/A	SFC	30.8	3.8		
100	34.1567	Q21-19	2.0003	2.0048	4.5000	5.0968	0.3051	0.4046	7.4810	0.6015	100.61	693.73	1.7	SF	22.5	0.4		
100	34.1568	Q21-19	1.9986	2.0003	1.7000	5.0927	0.3048	0.4034	7.4587	0.2279	104.50	720.50	1.6	SFC	18.1	3.8		
100	34.1569	Q21-19	1.9845	1.9889	4.4000	5.0980	0.3005	0.4034	7.4187	0.5931	108.34	747.02	2.0	SF	33.8	1.2		
100	34.1570	Q21-19	1.9930	1.9974	4.4000	5.0957	0.3045	0.4034	7.4602	0.5898	107.33	740.04	1.6	SF	16.2	0.6		
				Average	3.0000							0.4025	107.28				739.67	1.4
				Std. Dev.	1.8363							0.2464	4.95				34.13	0.7
200	34.1813	Q21-90-42	1.9811	1.9814	0.3000	5.1181	0.2951	0.3975	7.3248	0.0410	84.38	581.78	1.3	SFC	29.6	3.8		
200	34.1814	Q21-90-42	1.9829	1.9832	0.3000	5.1308	0.2987	0.3980	7.3873	0.0406	82.29	567.41	2.0	SF	32.8	1.8		
200	34.1815	Q21-90-42	1.9818	1.9818	0.0000	5.1308	0.2977	0.3980	7.3760	0.0000	86.12	593.83	2.2	SF	23.0	2.6		
200	34.1816	Q21-90-42	1.9810	1.9813	0.3000	5.1181	0.2979	0.3975	7.3557	0.0408	97.69	673.56	2.0	SF	32.7	2.1		
200	34.1817	Q21-90-42	1.9803	1.9805	0.2000	5.1689	0.2997	0.3978	7.4489	0.0268	92.92	640.66	1.5	SFC	30.8	3.8		
				Average	0.2200							0.0298	88.68				611.45	1.8
				Std. Dev.	0.1166							0.0159	5.74				39.60	0.3
500	34.1818	Q21-90-42	1.9771	1.9775	0.4000	5.0902	0.2985	0.4001	7.3497	0.0544	111.90	771.58	1.8	SF	17.5	1.6		

OXIDATION BEHAVIOR OF PY6 SILICON NITRIDE AT 1000°C (1832°F)

TIME Hrs.	Specimen Number	Lot Number	Weight Before gm	Weight After gm	Weight Change (m), mg	Length cm	Height cm	Width cm	Surface Area (A) cm.^2	m/A mg/cm^2	Oxide Layer Thickness uM	Flexural Strength		Failure Origin	Coordinates of Failure Origin (mm)	
												KSI	MPa.		X	Y
100	34.1752	Q21-90-42	1.9757	1.9757	0.0000	5.0889	0.4001	0.3007	7.3731	0.0000	112.34	774.56	0.6			
100	34.1753	Q21-90-42	1.9845	1.9845	0.0000	5.0902	0.4001	0.3007	7.3748	0.0000	82.92	571.70	0	SFC	32.0	0.0
100	34.1754	Q21-90-42	1.9826	1.9826	0.0000	5.0876	0.4003	0.3007	7.3740	0.0000	130.98	903.08	N/A	SI	30.0	3.7
100	34.1755	Q21-90-42	1.9850	1.9850	0.0000	5.0889	0.4003	0.3025	7.3953	0.0000	141.59	976.28	0	SF	29.6	2.8
100	34.1756	Q21-90-42	1.9829	1.9829	0.0000	5.0876	0.3988	0.3010	7.3604	0.0000	147.64	1018.00	0	SFC	28.8	0.2
				Average	0.0000					0.0000	123.09	848.72	0.1			
				Std. Dev.	0.0000					0.0000	23.40	161.32	0.2			
500																
500	34.2231	Q21-90-64	2.0056	2.0056	0.0000	5.0800	0.4006	0.3043	7.4050	0.0000	157.98	1089.29	0	SFC	32.7	3.8
500	34.2232	Q21-90-64	2.0071	2.0071	0.0000	5.0808	0.3983	0.3030	7.3676	0.0000	173.50	1196.30	0	SF	26.2	2.0
500	34.2233	Q21-90-64	2.0059	2.0059	0.0000	5.0813	0.3993	0.3030	7.3792	0.0000	174.39	1202.40	0	SF	27.5	1.8
500	34.2234	Q21-90-64	2.0098	2.0098	0.0000	5.0805	0.4008	0.3033	7.3974	0.0000	144.61	997.12	0	SF	16.0	0.9
	34.2235	Q21-90-64	2.0069	2.0069	0.0000	5.0800	0.4013	0.3030	7.3993	0.0000	169.68	1169.91	0	SF	33.0	3.0
				Average	0.0000						164.03	1131.00	0.0			
				Std. Dev.	0.0000						11.33	78.15	0.0			

OXIDATION BEHAVIOR OF PY6 SILICON NITRIDE AT 1150°C (2102°F) IN AIR

TIME Hrs.	Specimen Number	Lot Number	Weight Before gm	Weight After gm	Weight Change (m), mg	Length cm	Height cm	Width cm	Surface Area (A) cm.^2	m/A mg/cm^2	Oxide Layer Thickness uM	Flexural Strength		Failure Origin	Coordinates of Failure Origin (mm)	
												KSI	MPa.		X	Y
100	34.1744	Q21-90-42	1.9888	1.9890	0.2000	5.0871	0.3015	0.4001	7.3789	0.2696	90.48	623.86	1.7	II	14.6	1.4
100	34.1745	Q21-90-42	1.9877	1.9880	0.3000	5.0907	0.3015	0.4003	7.3867	0.2691	97.34	671.14	1.6	SFC	17.2	0.2
100	34.1746	Q21-90-42	1.9857	1.9859	0.2000	5.0902	0.3012	0.4003	7.3832	0.2690	99.63	686.97	1.3	SFC	23.6	0.1
100	34.1748	Q21-90-42	1.9865	1.9868	0.3000	5.0876	0.3012	0.4003	7.3796	0.2692	99.63	686.97	1.7	SFC	33.2	3.8
100	34.1749	Q21-90-42	1.9845	1.9847	0.2000	5.0874	0.3010	0.4001	7.3737	0.2692	92.92	640.70	1.6	SF	29.0	2.4
				Average	0.2400					0.2692	96.00	661.93	1.6			
				Std. Dev.	0.0490					0.0002	3.69	25.45	0.1			

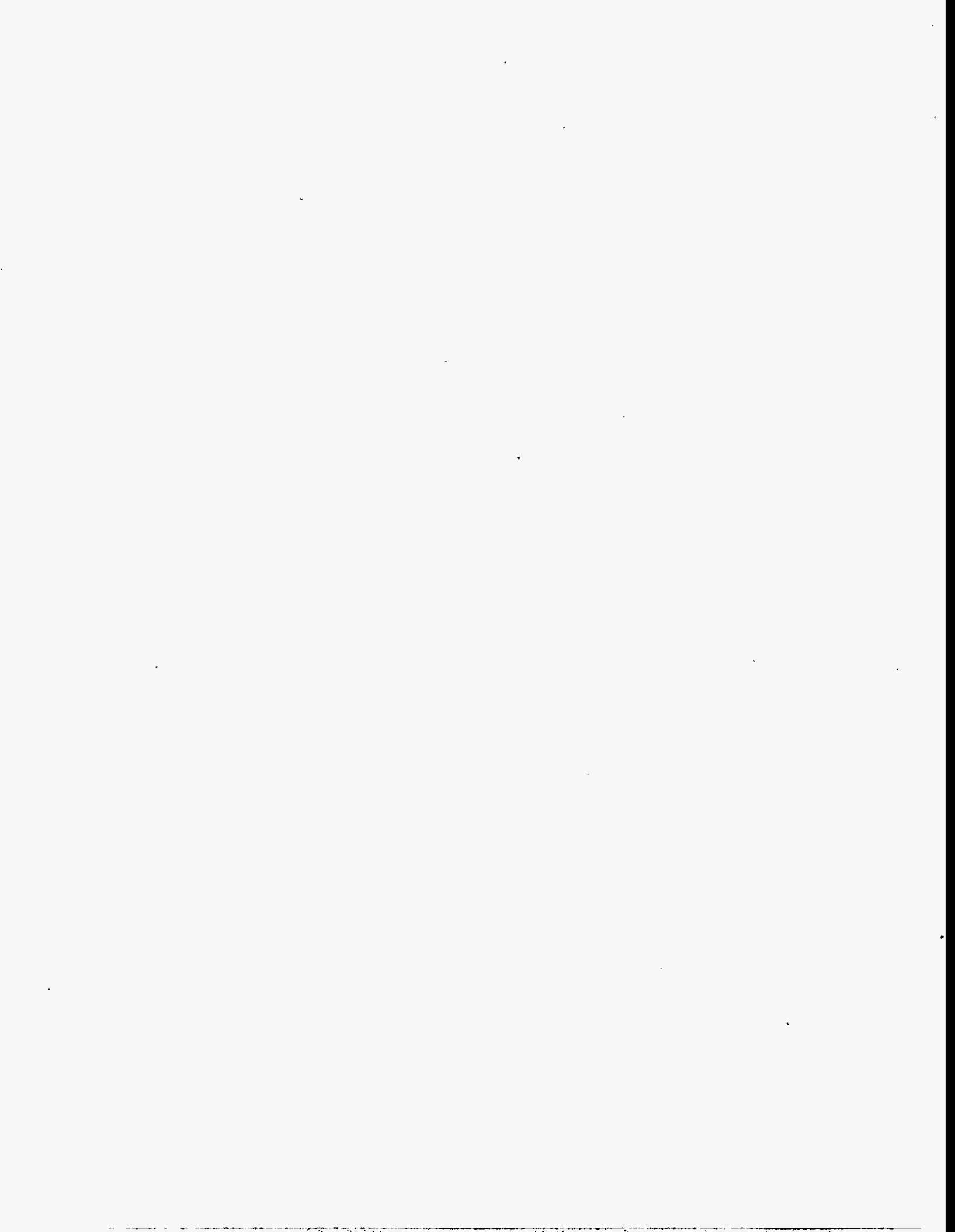
OXIDATION BEHAVIOR OF PY6 SILICON NITRIDE AT 1100°C (2012°F) IN AIR

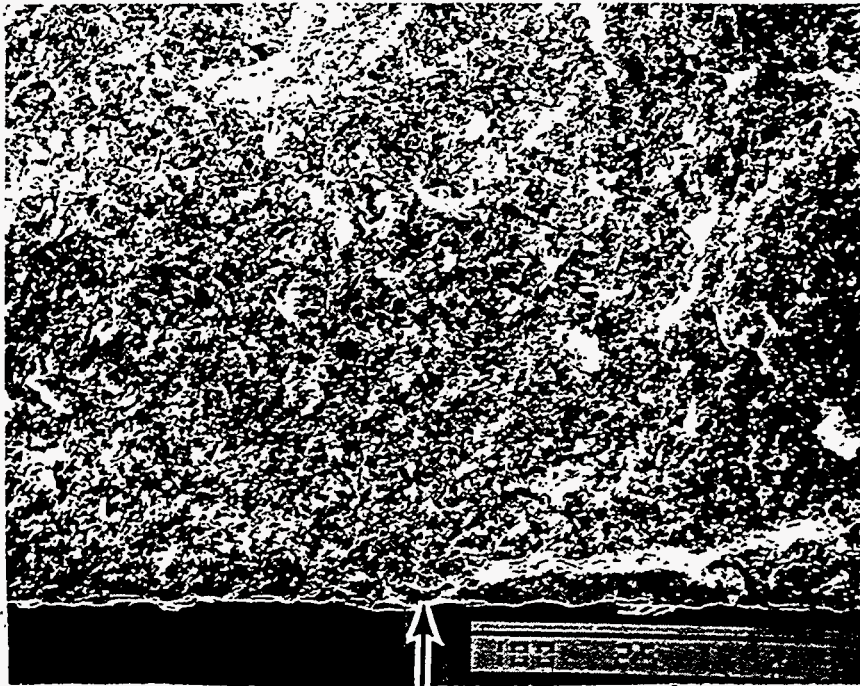
TIME Hrs.	Specimen Number	Lot Number	Weight Before gm	Weight After gm	Weight Change (m), mg	Length cm	Height cm	Width cm	Surface Area (A) cm.^2	m/A mg/cm^2	Oxide Layer Thickness uM	Flexural Strength		Failure Origin	Coordinates of Failure Origin (mm)	
												KSI	MPa.		X	Y
100	34.1730	Q21-90-42	1.9889	1.9891	0.2000	5.0889	0.3010	0.4001	7.3759	0.0271	96.85	667.75	1.5	SF	20.5	0.0
100	34.1731	Q21-90-42	1.9875	1.9877	0.2000	5.0876	0.3010	0.4013	7.3878	0.0271	101.27	698.28	1.0	SFC	22.3	0.2
100	34.1732	Q21-90-42	1.9898	1.9898	0.0000	5.0902	0.3010	0.4001	7.3776	0.0000	87.27	601.71	1.0	SFC	21.6	0.2
100	34.1733	Q21-90-42	1.9882	1.9883	0.1000	5.0889	0.3010	0.4001	7.3759	0.0136	131.74	908.37	1.0	SF	23.3	0.3
100	34.1735	Q21-90-42	1.9898	1.9899	0.1000	5.0864	0.3010	0.4001	7.3723	0.0136	104.19	718.36	0.5	SF	32.9	2.7
				Average	0.1200					0.0163	104.26	718.89	1.0			
				Std. Dev.	0.0748					0.0101	14.89	102.64	0.3			

OXIDATION BEHAVIOR OF PY6 SILICON NITRIDE AT 1000°C (1832°F)

TIME Hrs.	Specimen Number	Lot Number	Weight Before gm	Weight After gm	Weight Change (m), mg	Length cm	Height cm	Width cm	Surface Area (A) cm.^2	m/A mg/cm^2	Oxide Layer Thickness uM	Flexural Strength		Failure Origin	Coordinates of Failure Origin (mm)	
												KSI	MPa.		X	Y
100	34.1752	Q21-90-42	1.9757	1.9757	0.0000	5.0889	0.4001	0.3007	7.3731	0.0000	112.34	774.56	0.6			
100	34.1753	Q21-90-42	1.9845	1.9845	0.0000	5.0902	0.4001	0.3007	7.3748	0.0000	82.92	571.70	0	SFC	32.0	0.0
100	34.1754	Q21-90-42	1.9826	1.9826	0.0000	5.0876	0.4003	0.3007	7.3740	0.0000	130.98	903.08	N/A	SI	30.0	3.7
100	34.1755	Q21-90-42	1.9850	1.9850	0.0000	5.0889	0.4003	0.3025	7.3953	0.0000	141.59	976.28	0	SF	29.6	2.8
100	34.1756	Q21-90-42	1.9829	1.9829	0.0000	5.0876	0.3988	0.3010	7.3604	0.0000	147.64	1018.00	0	SFC	28.8	0.2
				Average	0.0000					0.0000	123.09	848.72	0.1			
				Std. Dev.	0.0000					0.0000	23.40	161.32	0.2			
500																
500	34.2231	Q21-90-64	2.0056	2.0056	0.0000	5.0800	0.4006	0.3043	7.4050	0.0000	157.98	1089.29	0	SFC	32.7	3.8
500	34.2232	Q21-90-64	2.0071	2.0071	0.0000	5.0808	0.3983	0.3030	7.3676	0.0000	173.50	1196.30	0	SF	26.2	2.0
500	34.2233	Q21-90-64	2.0059	2.0059	0.0000	5.0813	0.3993	0.3030	7.3792	0.0000	174.39	1202.40	0	SF	27.5	1.8
500	34.2234	Q21-90-64	2.0098	2.0098	0.0000	5.0805	0.4008	0.3033	7.3974	0.0000	144.61	997.12	0	SF	16.0	0.9
	34.2235	Q21-90-64	2.0069	2.0069	0.0000	5.0800	0.4013	0.3030	7.3993	0.0000	169.68	1169.91	0	SF	33.0	3.0
				Average	0.0000						164.03	1131.00	0.0			
				Std. Dev.	0.0000						11.33	78.15	0.0			

OXIDATION BEHAVIOR OF PY-6 SILICON NITRIDE AT 1000°C

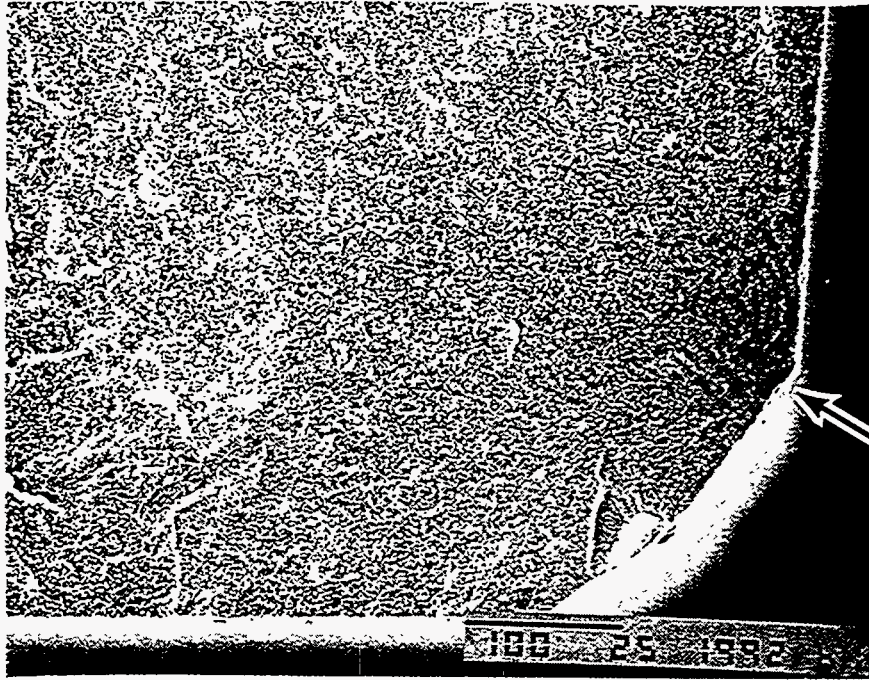




Specimen Number: 34.1752
Oxidation Temperature: 1000°C

Oxidation Time: 100 hr

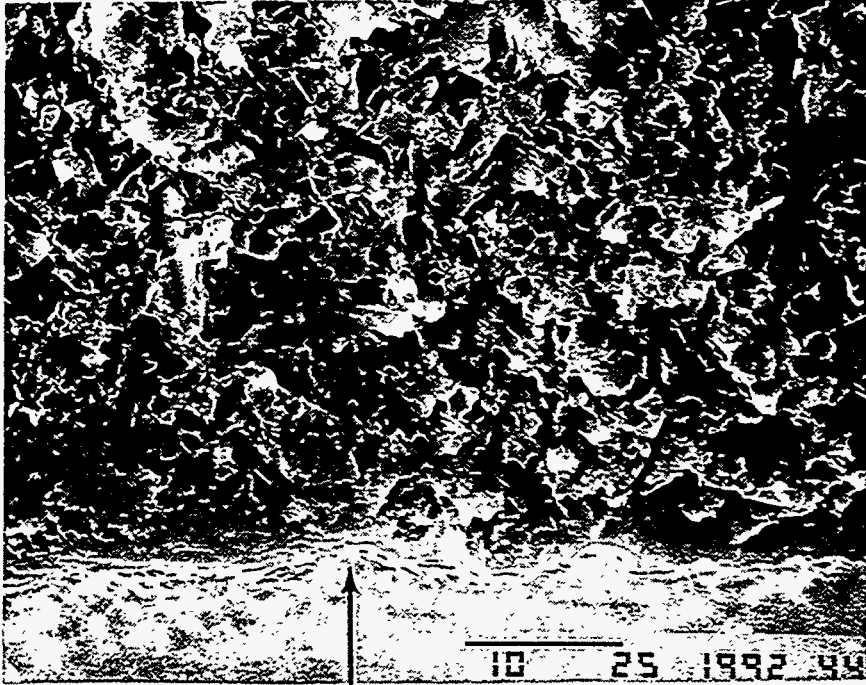




Specimen Number: 34.1753

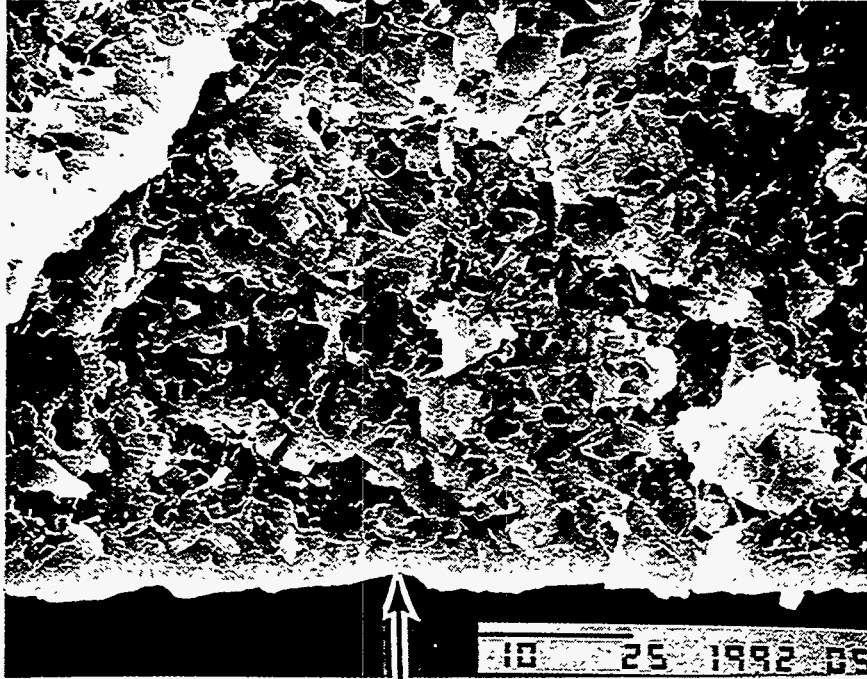
Oxidation Temperature: 1000°C

Oxidation Time: 100 hr



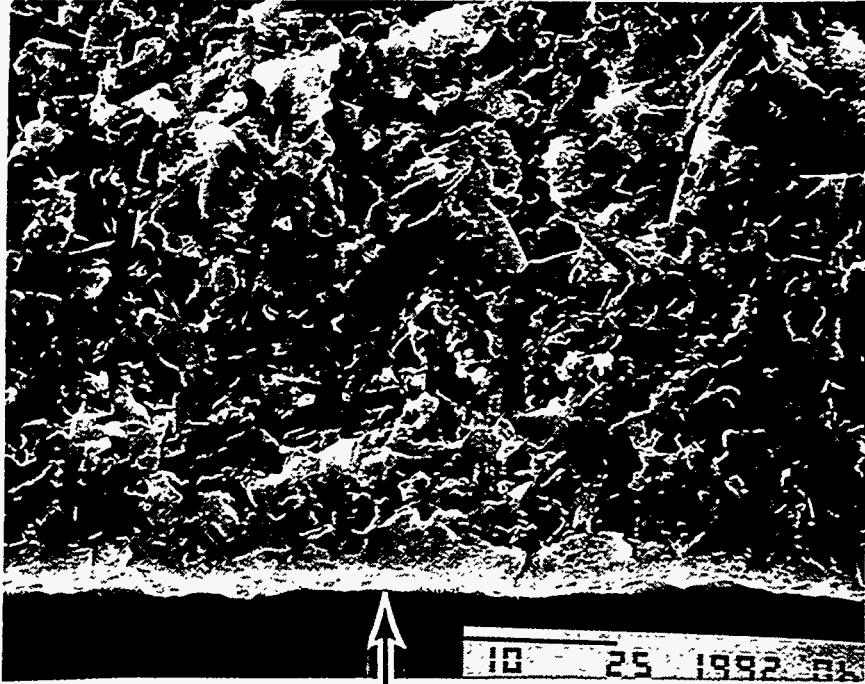
Specimen Number: 34.1756
Oxidation Temperature: 1000°C

Oxidation Time: 100 hr



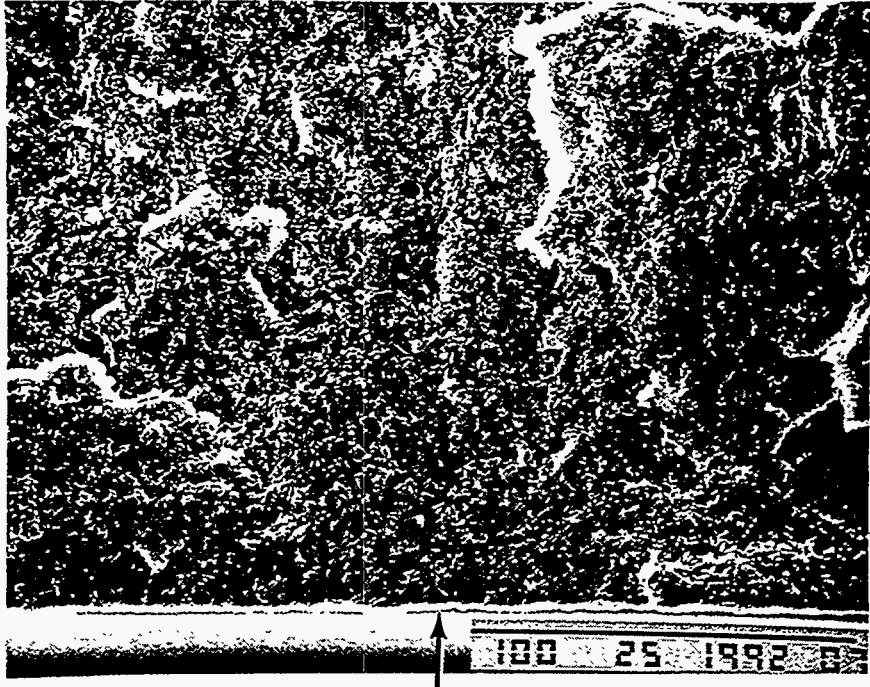
Specimen Number: 34.2232
Oxidation Temperature: 1000°C

Oxidation Time: 500 hr



Specimen Number: 34.2234
Oxidation Temperature: 1000°C

Oxidation Time: 500 hr



Specimen Number: 34.2235
Oxidation Temperature: 1000°C

Oxidation Time: 500 hr



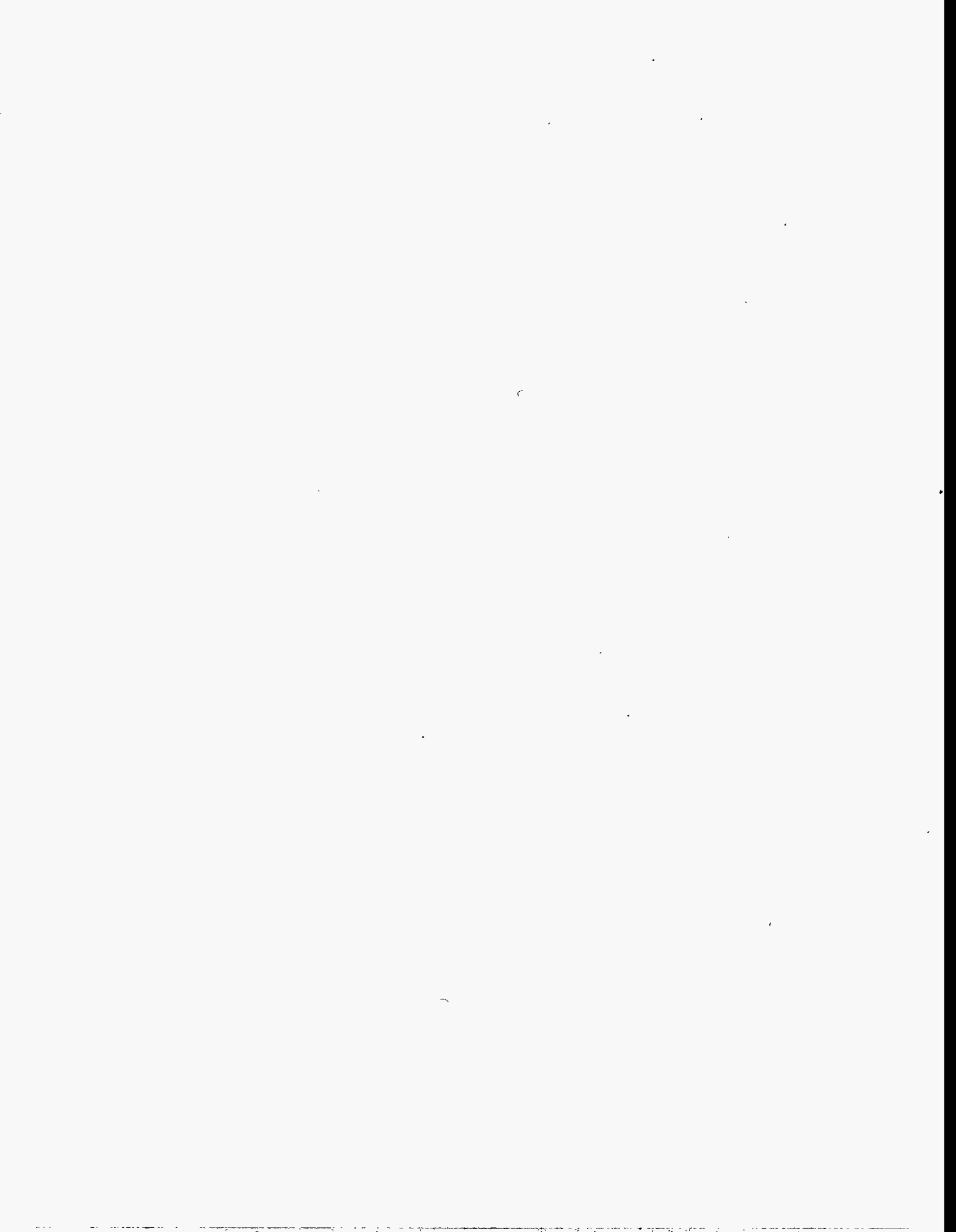
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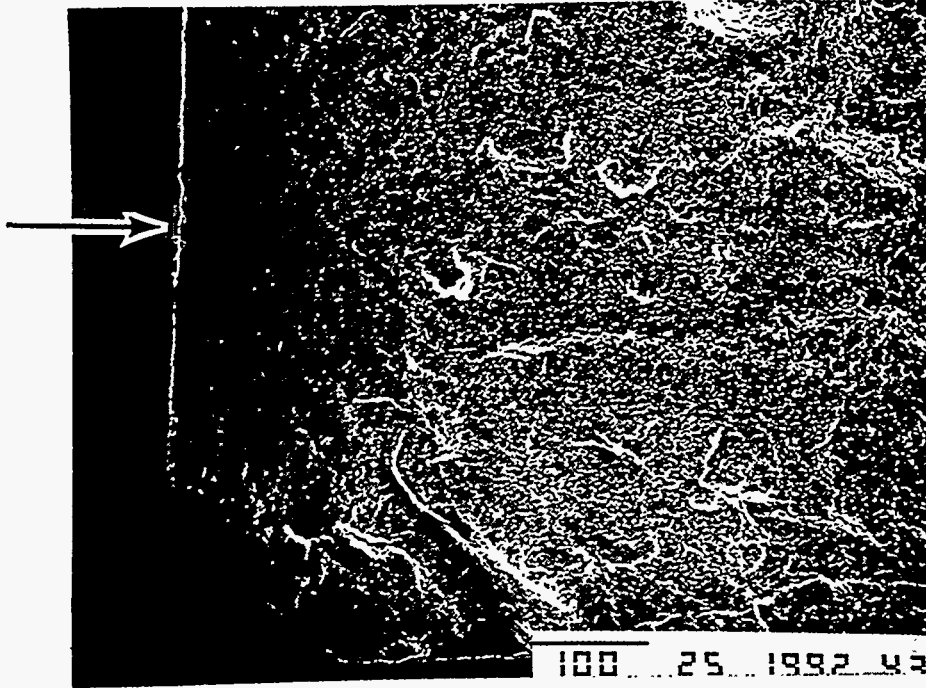
Specimen Number: 34.2235

Oxidation Temperature: 1000°C

Oxidation Time: 500 hr

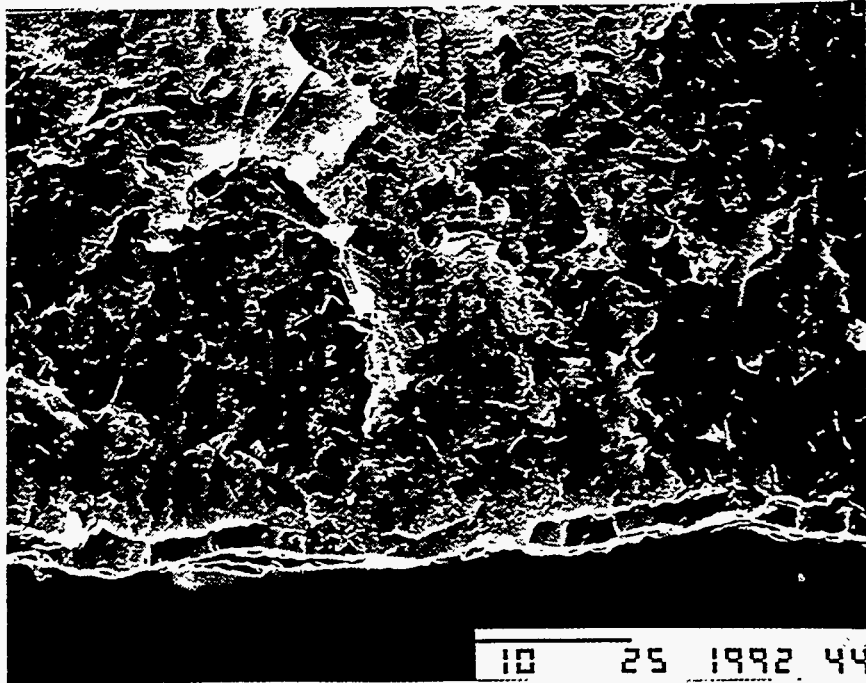
OXIDATION BEHAVIOR OF PY-6 SILICON NITRIDE AT 1100°C IN AIR

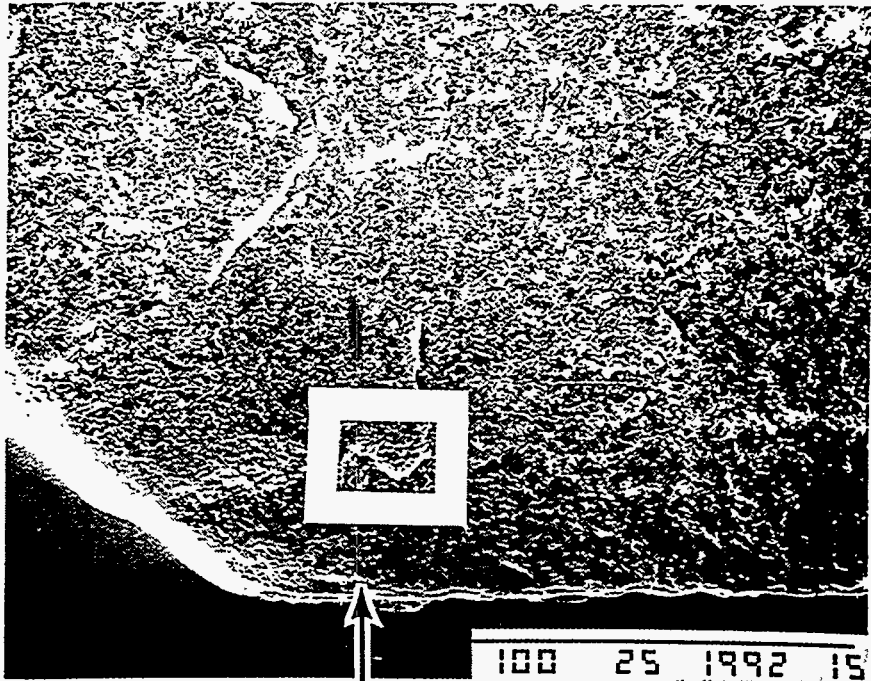




Specimen Number: 34.1730
Oxidation Temperature: 1100°C

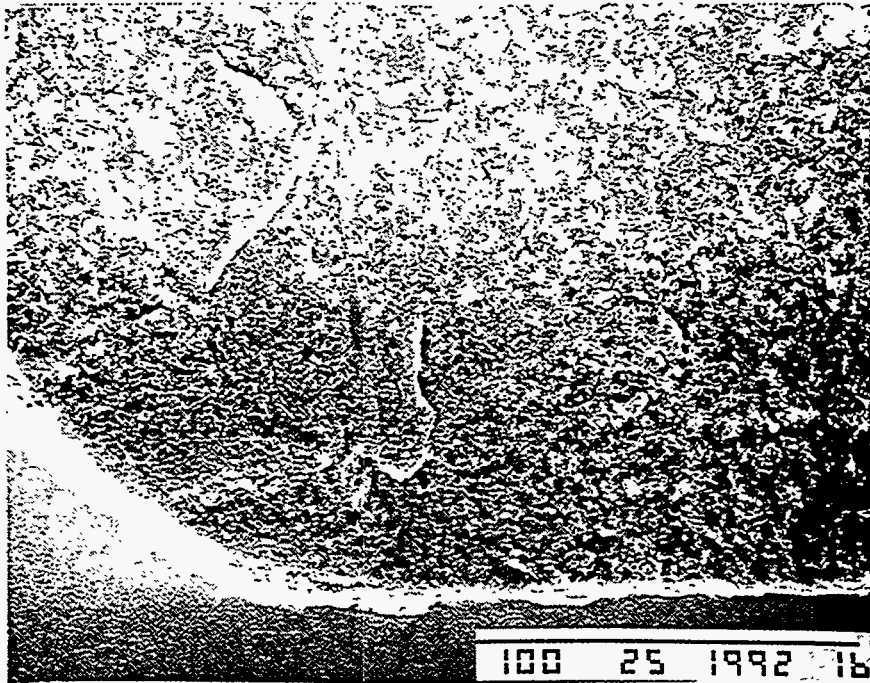
Oxidation Time: 100 hr

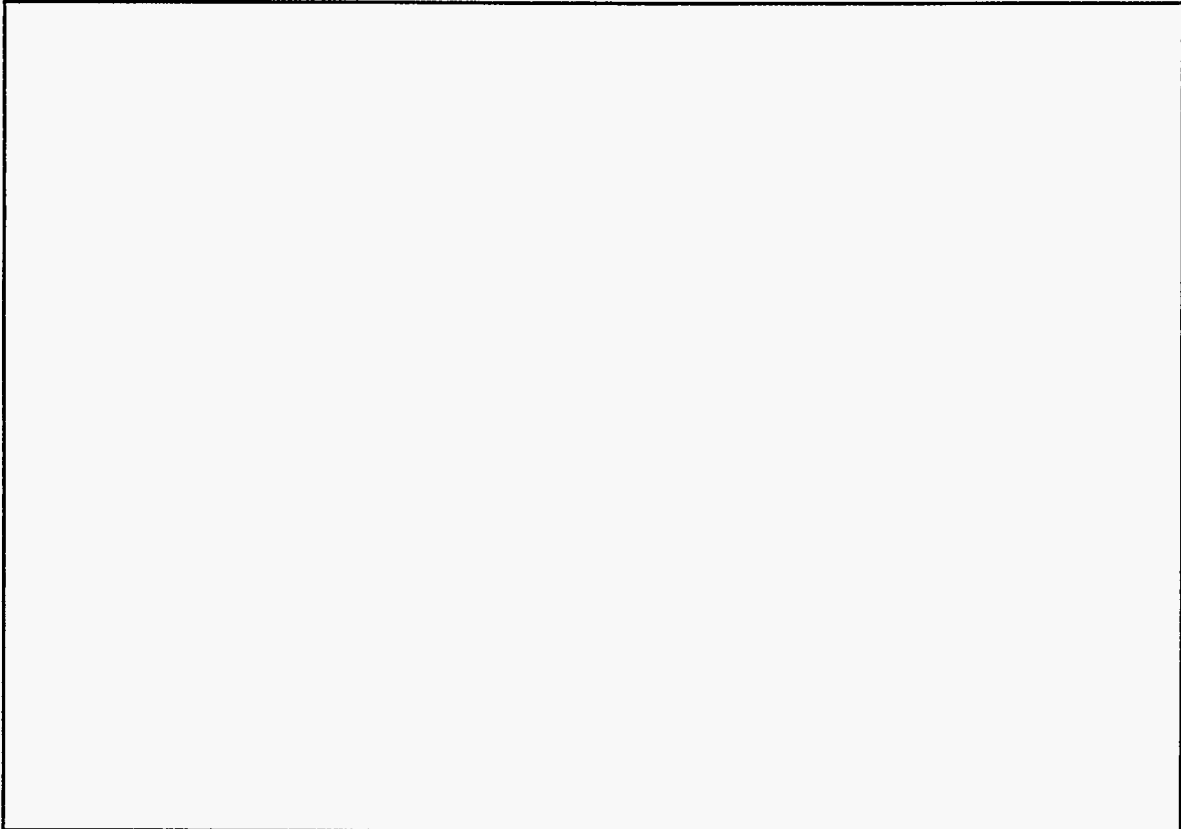




Specimen Number: 34.1731
Oxidation Temperature: 1100°C

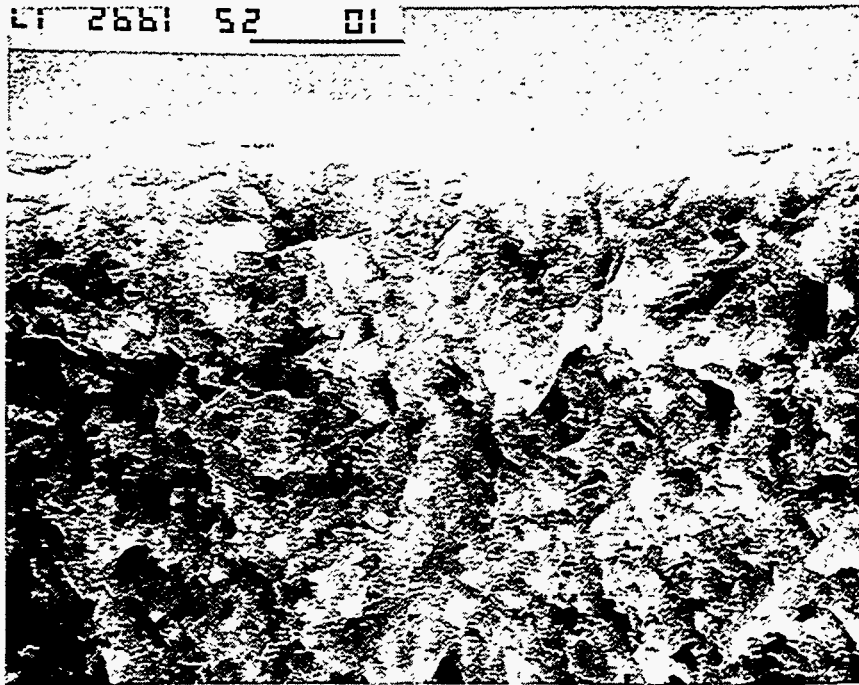
Oxidation Time: 100 hr

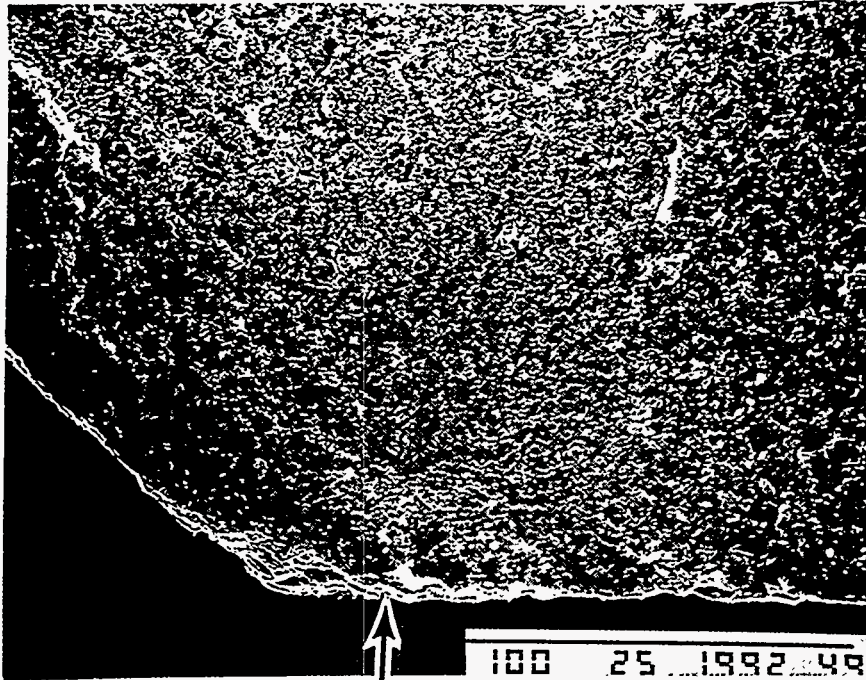




Specimen Number: 34.1731
Oxidation Temperature: 1100°C

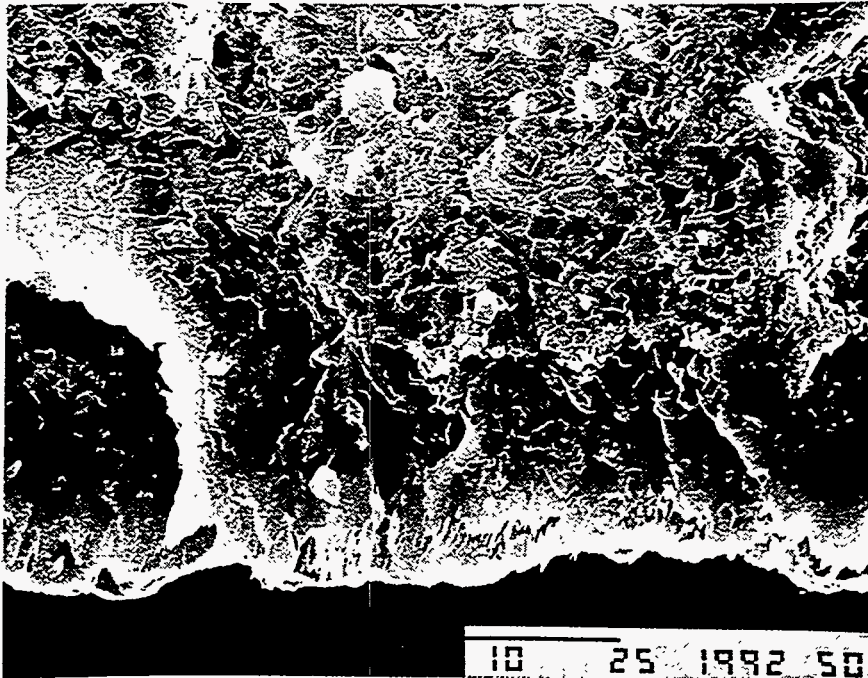
Oxidation Time: 100 hr

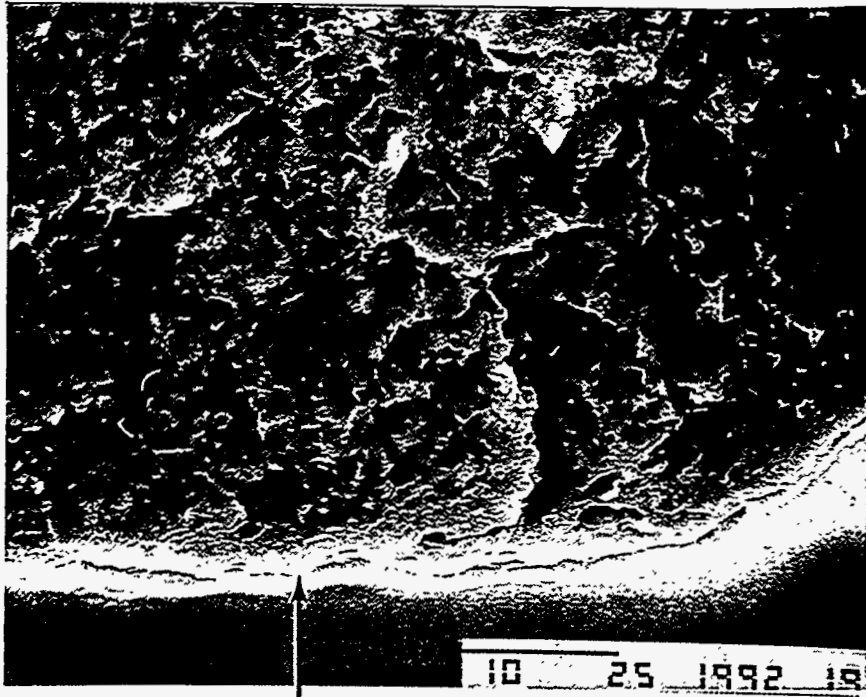




Specimen Number: 34.1732
Oxidation Temperature: 1100°C

Oxidation Time: 100 hr

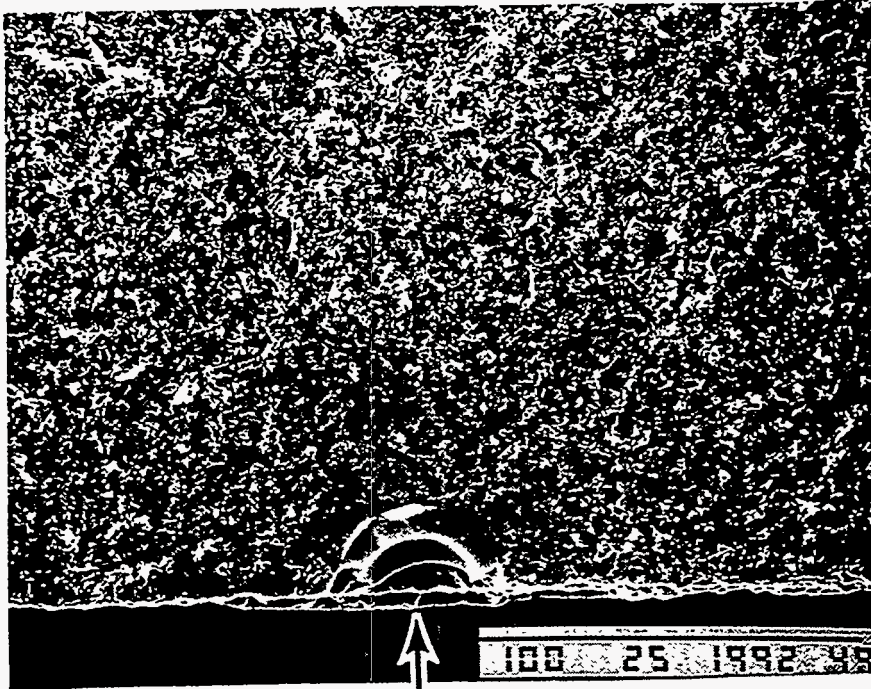




Specimen Number: 34.1733

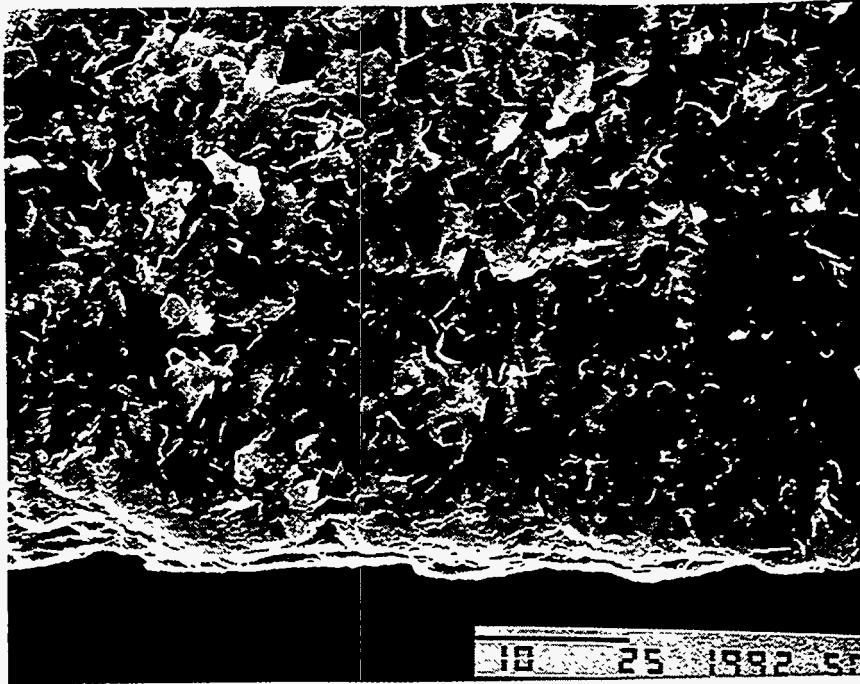
Oxidation Temperature: 1100°C

Oxidation Time: 100 hr

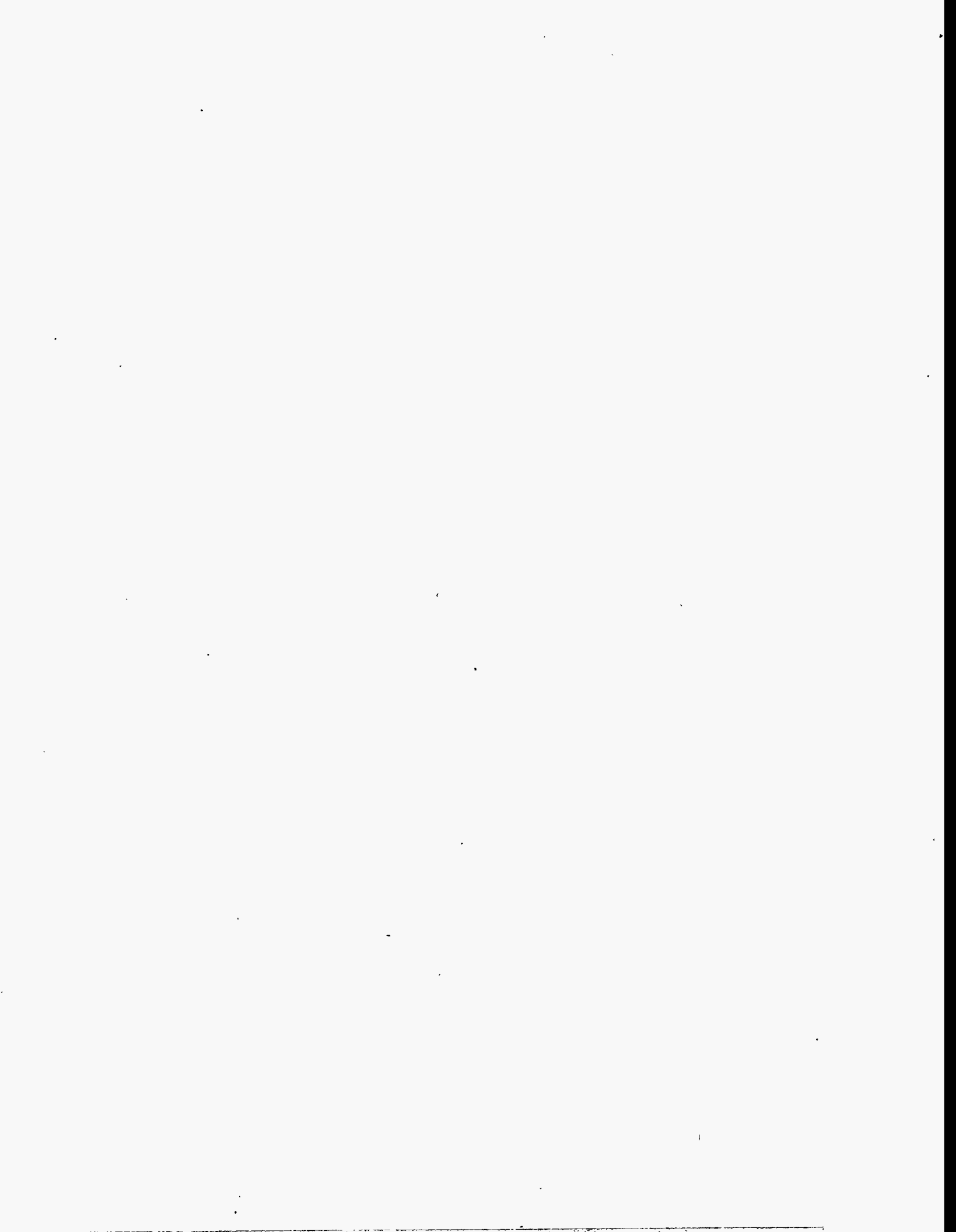


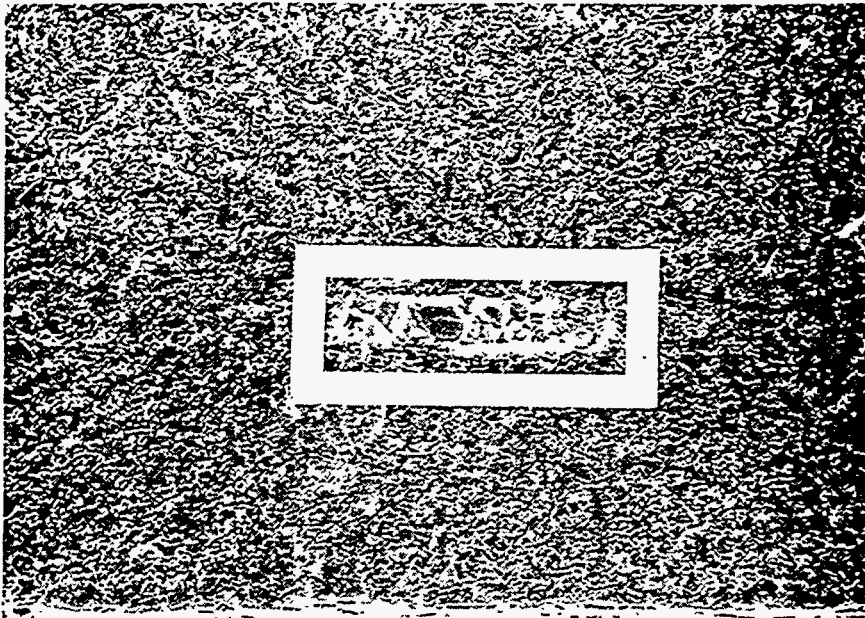
Specimen Number: 34.1735
Oxidation Temperature: 1100°C

Oxidation Time: 100 hr



OXIDATION BEHAVIOR OF PY-6 SILICON NITRIDE AT 1150°C IN AIR





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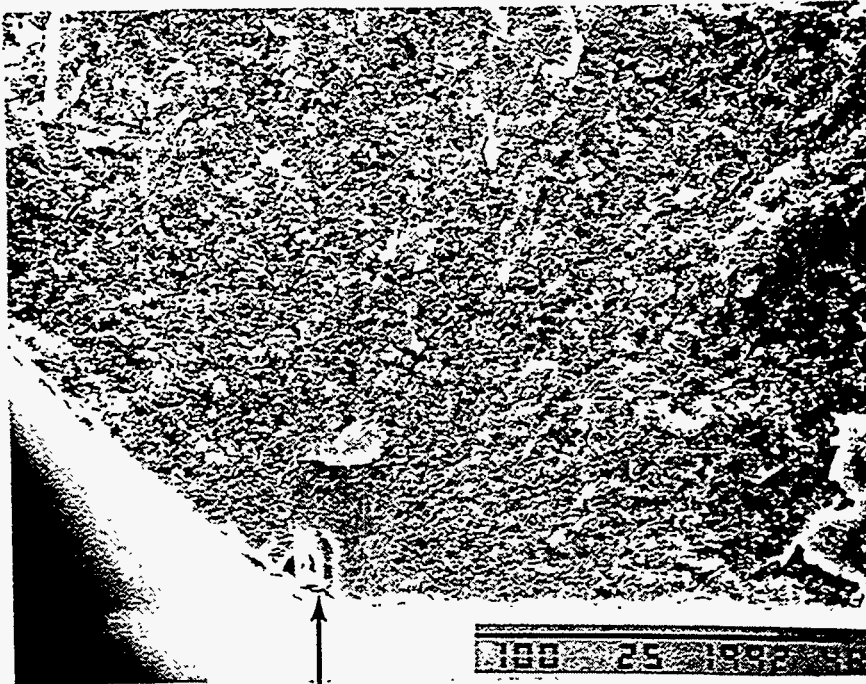
Specimen Number: 34.1744

Oxidation Temperature: 1150°C

Oxidation Time: 100 hr

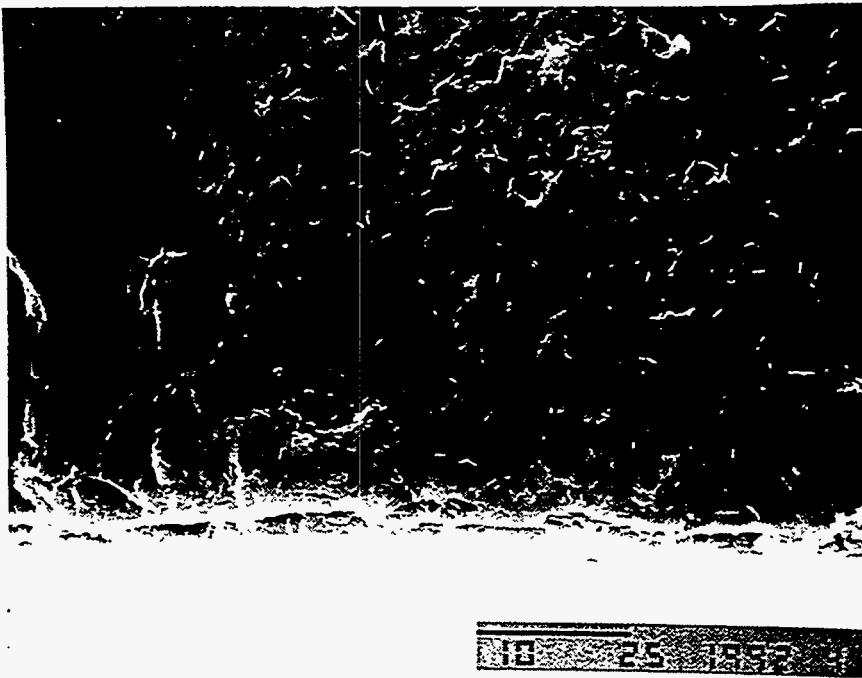


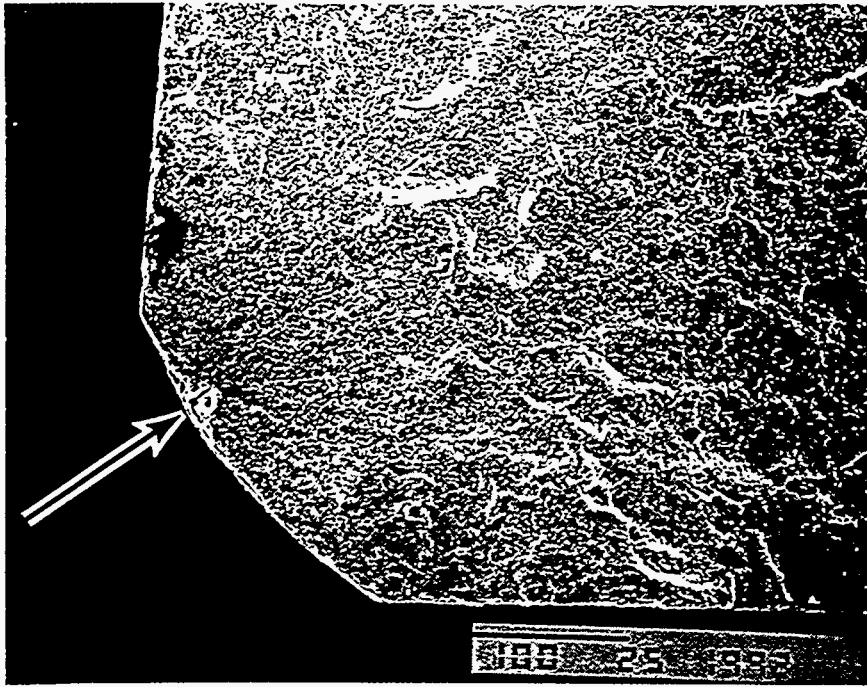
10 25 1992 03



Specimen Number: 34.1745
Oxidation Temperature: 1150°C

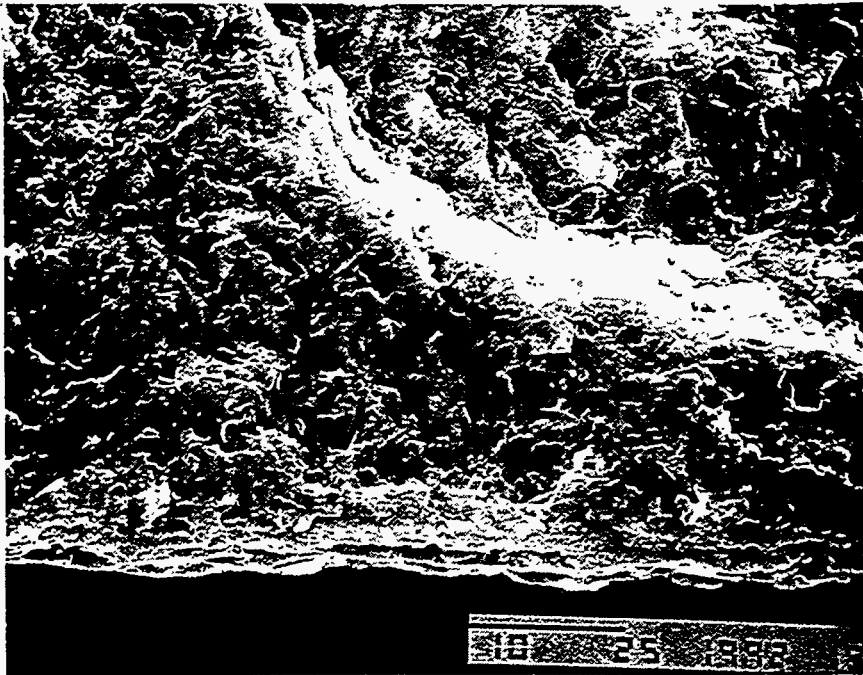
Oxidation Time: 100 hr

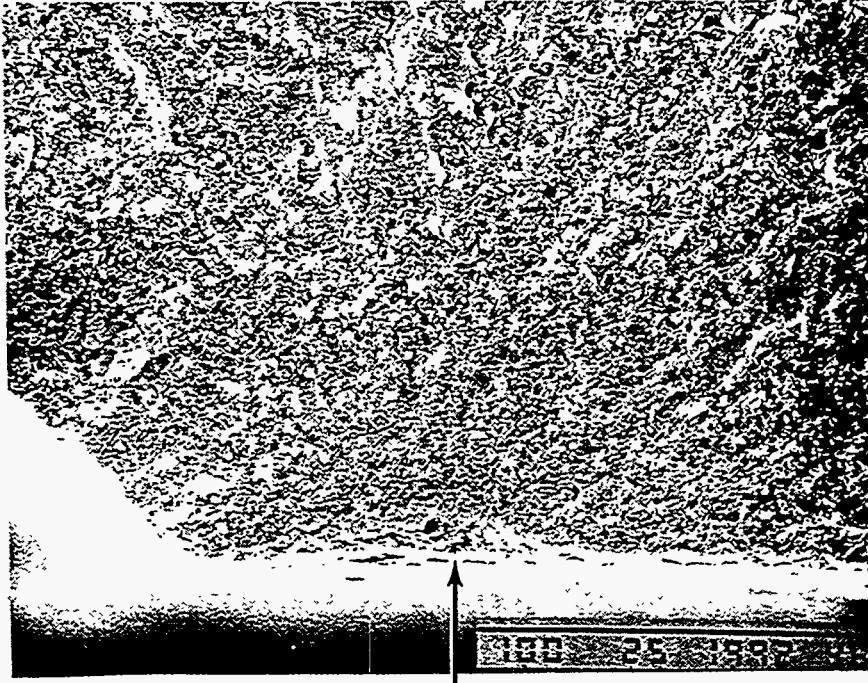




Specimen Number: 34.1746
Oxidation Temperature: 1150°C

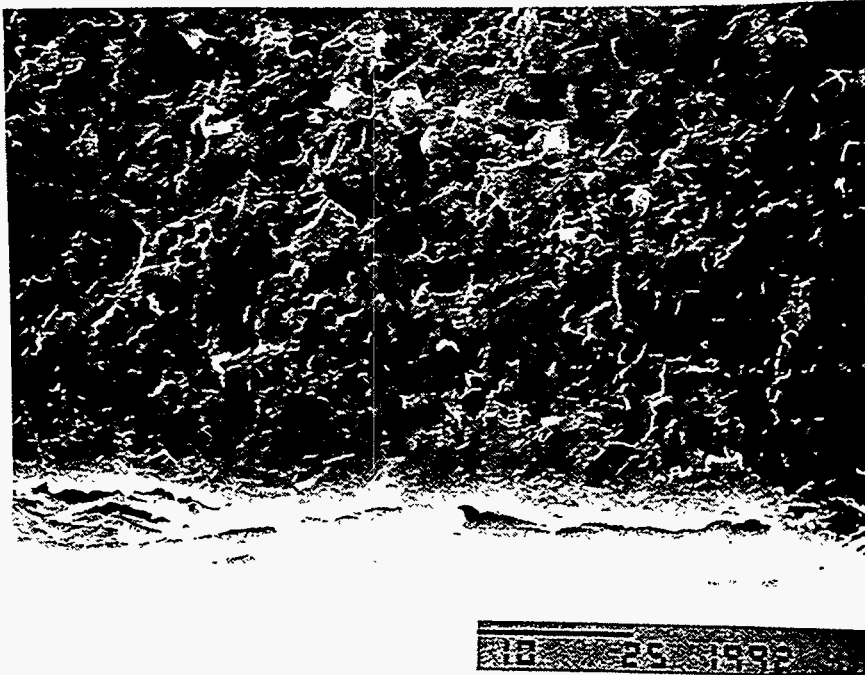
Oxidation Time: 100 hr

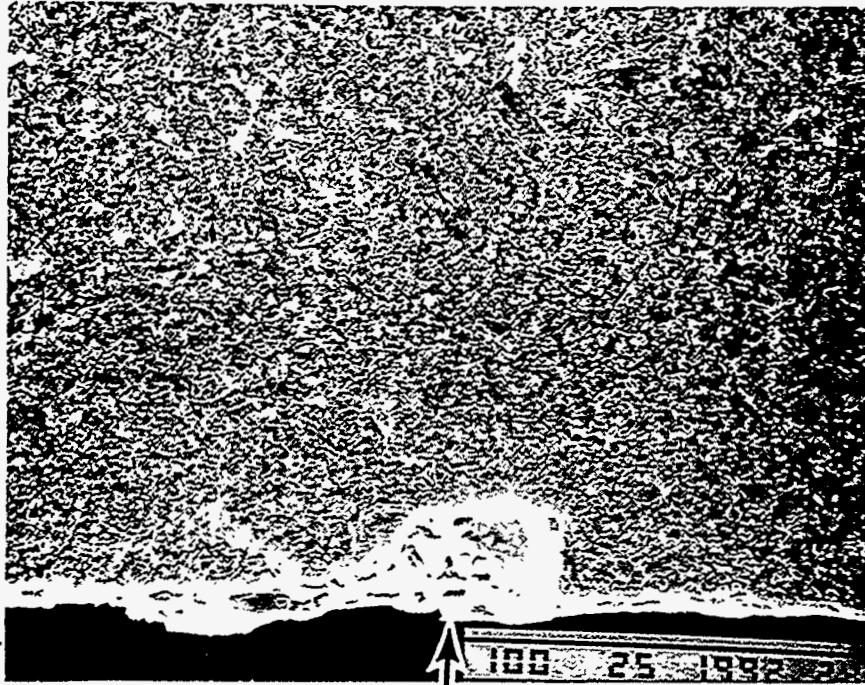




Specimen Number: 34.1748
Oxidation Temperature: 1150°C

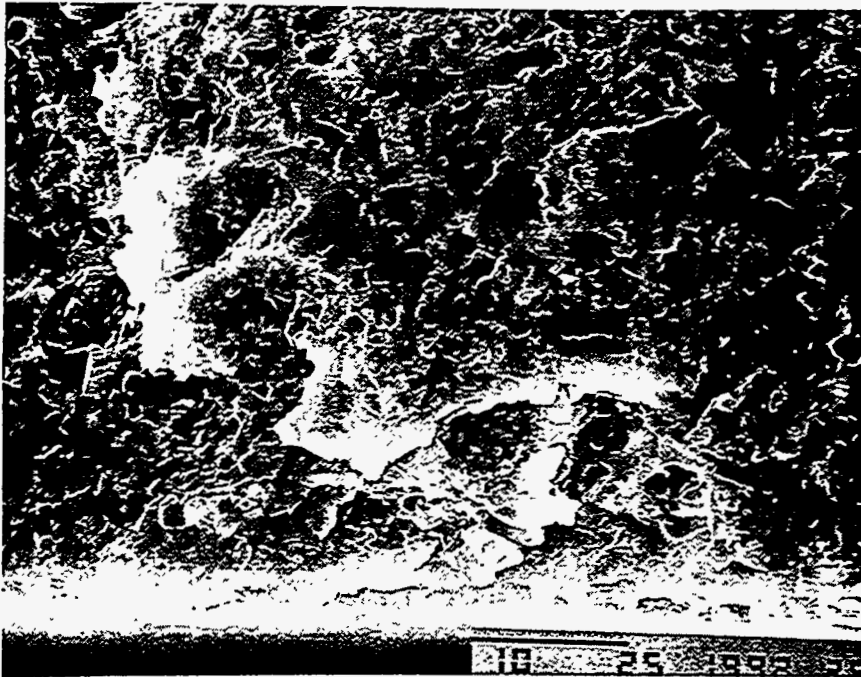
Oxidation Time: 100 hr



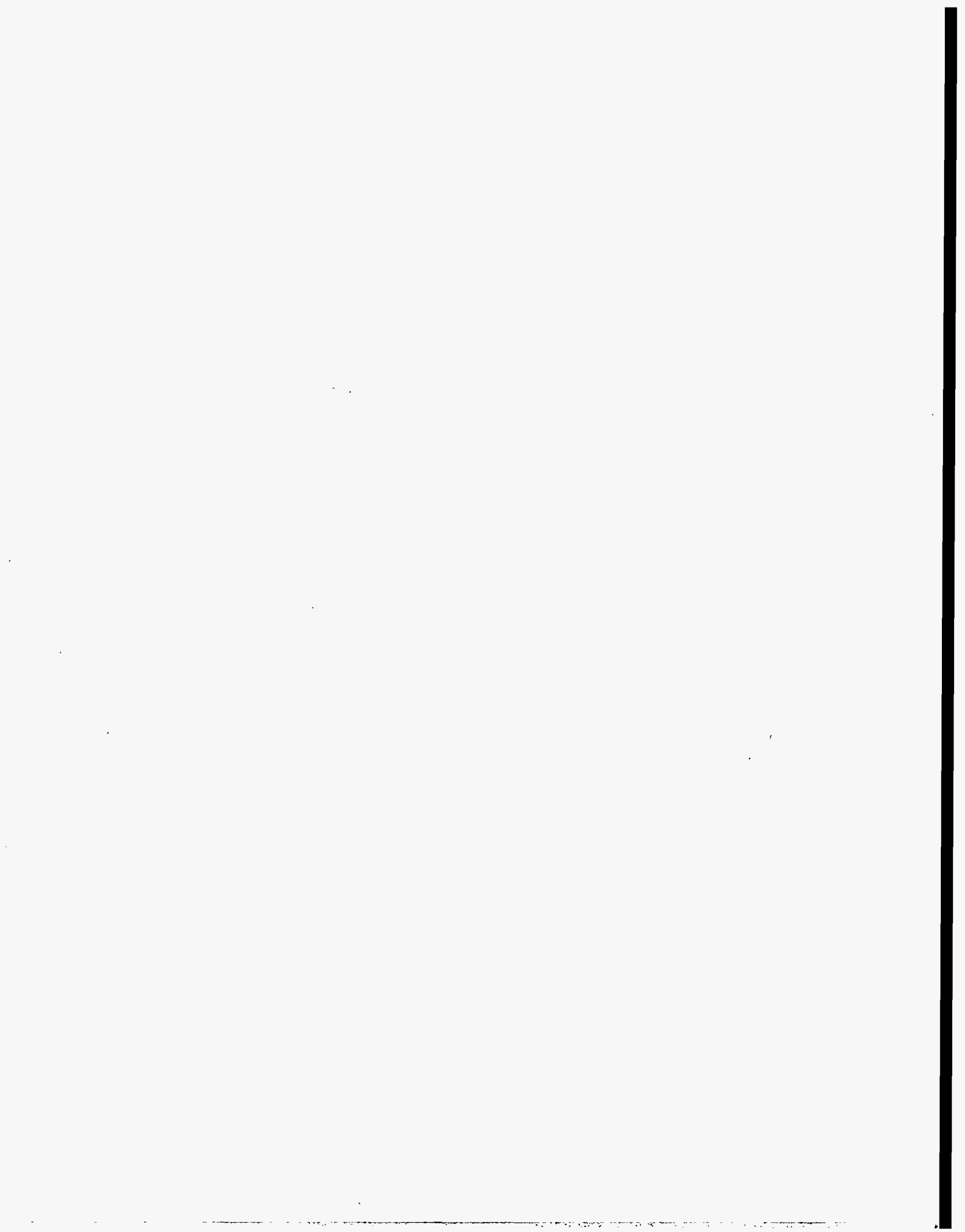


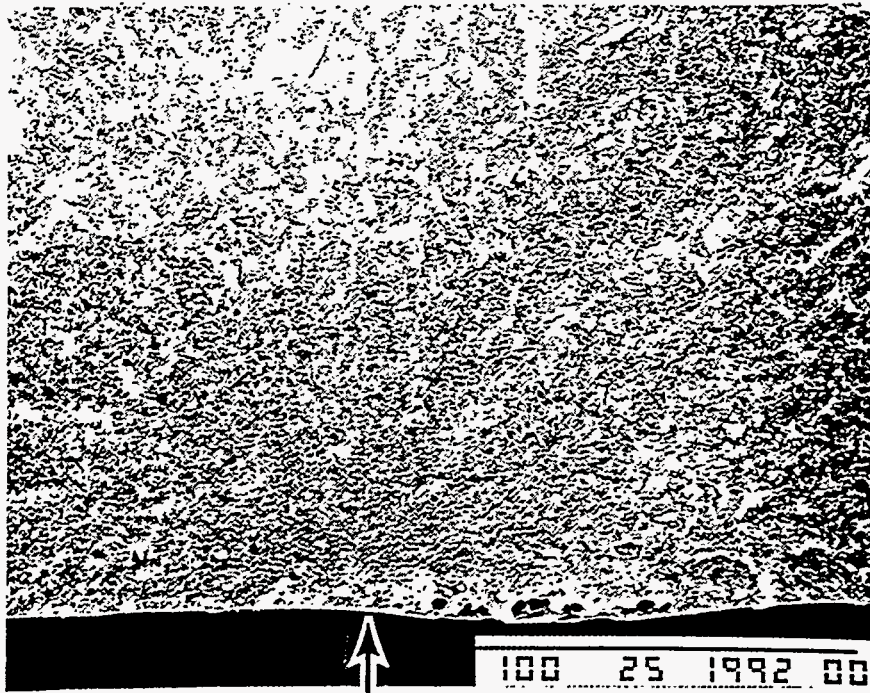
Specimen Number: 34.1749
Oxidation Temperature: 1150°C

Oxidation Time: 100 hr



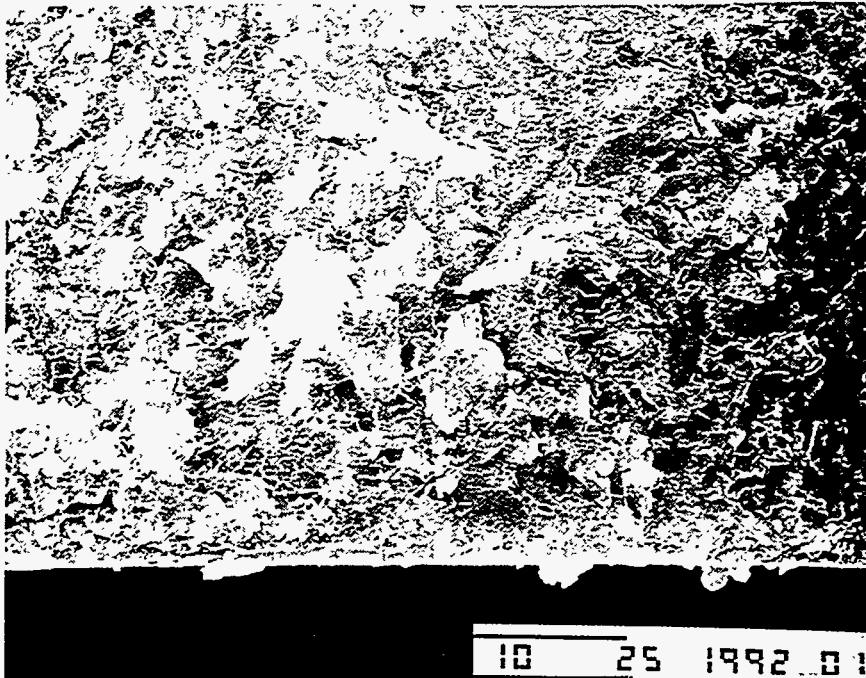
OXIDATION BEHAVIOR OF PY-6 SILICON NITRIDE AT 1200°C IN AIR

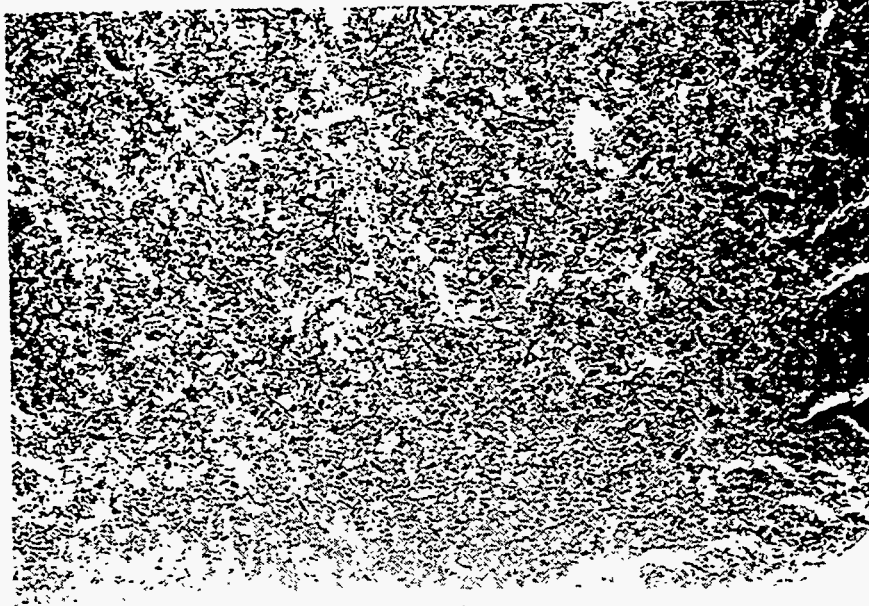




Specimen Number: 34.2056
Oxidation Temperature: 1200°C

Oxidation Time: 1 hr

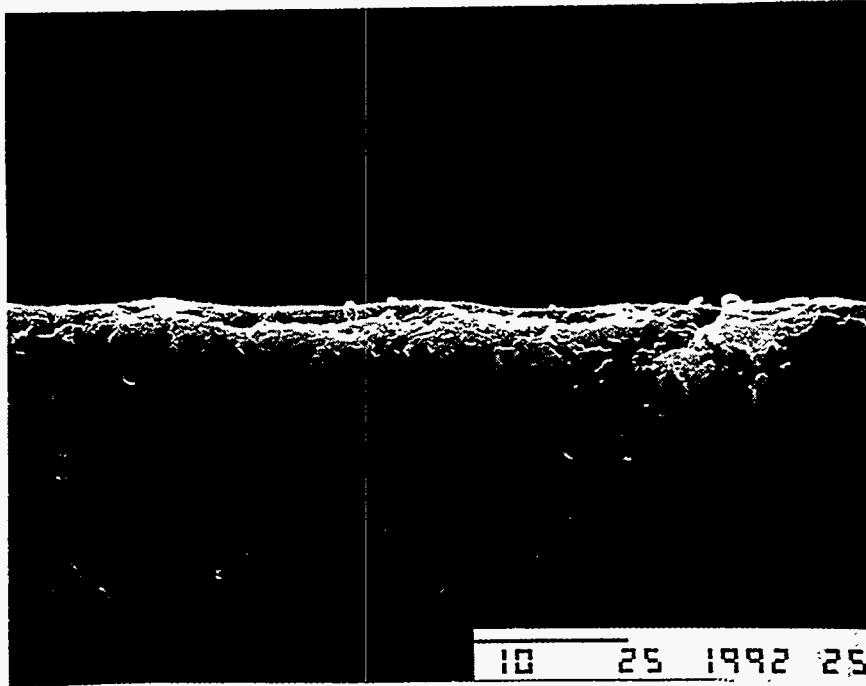




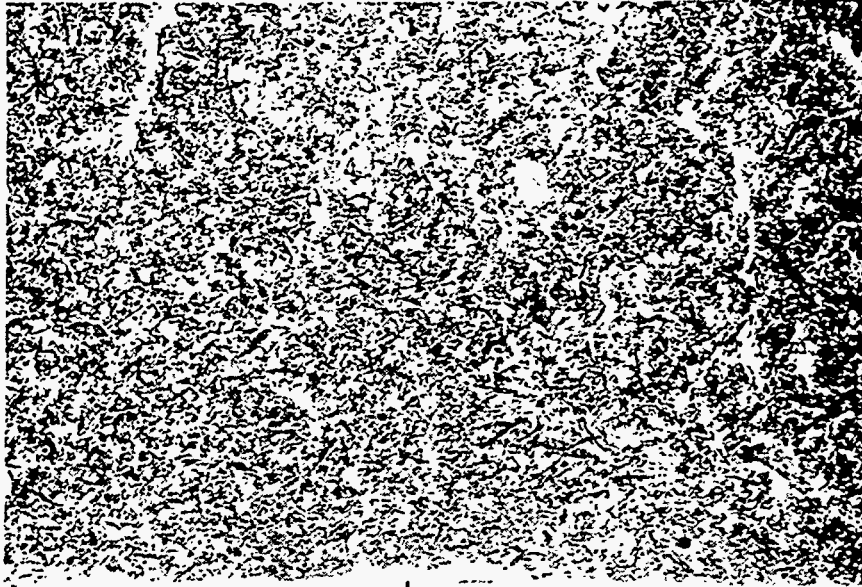
100 25 1992 24

Specimen Number: 34.2057
Oxidation Temperature: 1200°C

Oxidation Time: 1 hr



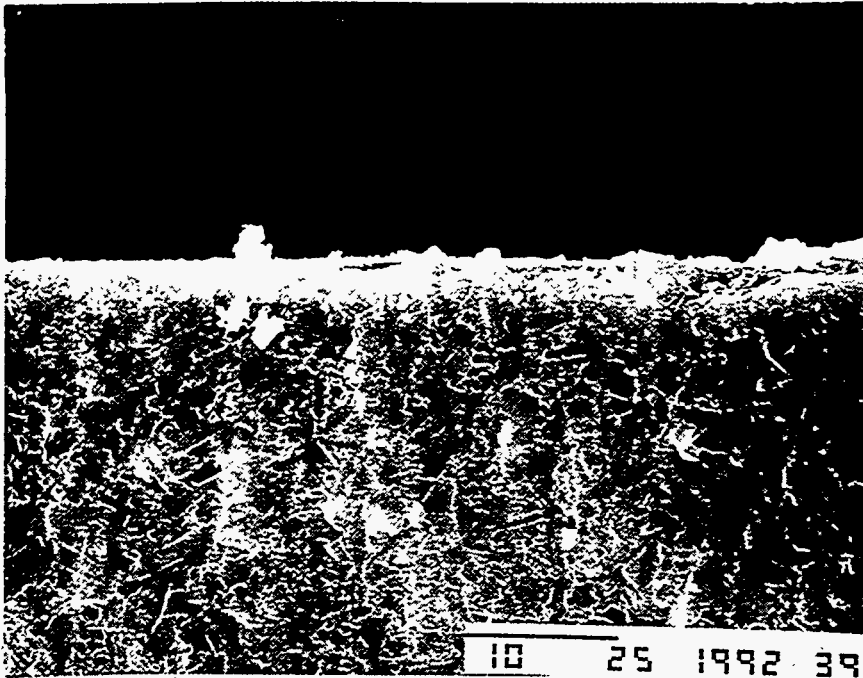
10 25 1992 25



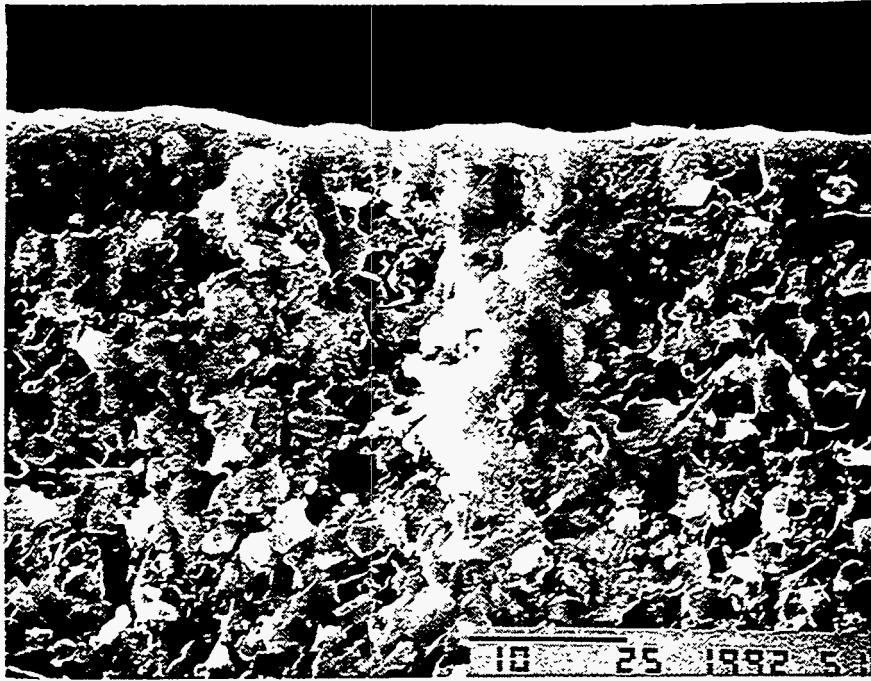
100 25 1992 38

Specimen Number: 34.2058
Oxidation Temperature: 1200°C

Oxidation Time: 1 hr

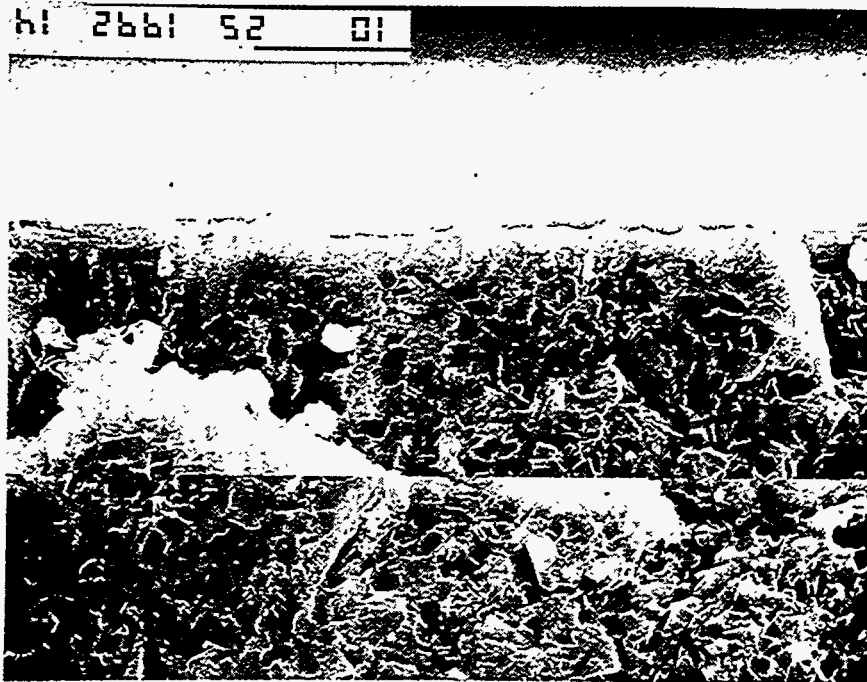


10 25 1992 39



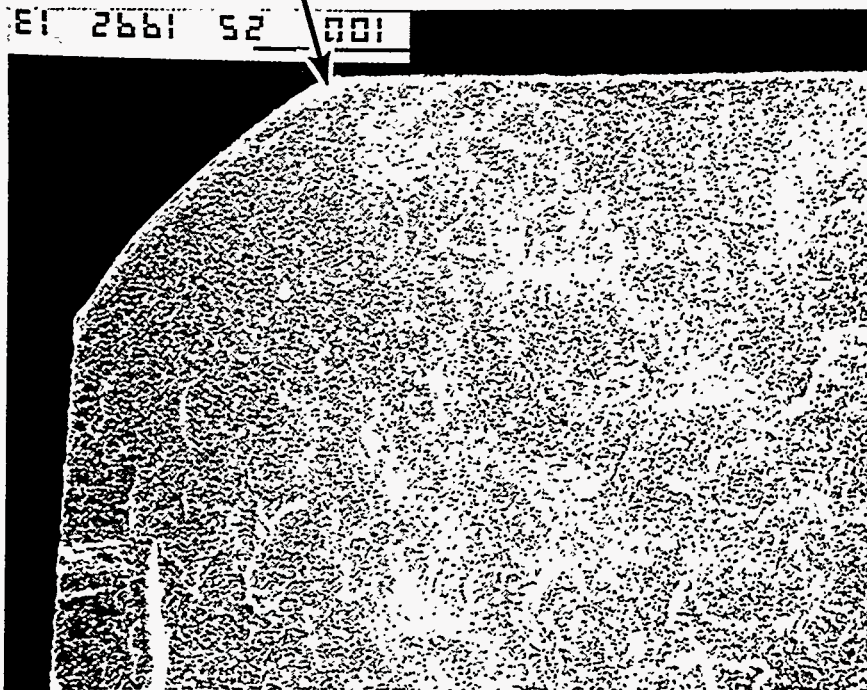
Specimen Number: 34.2059
Oxidation Temperature: 1200°C

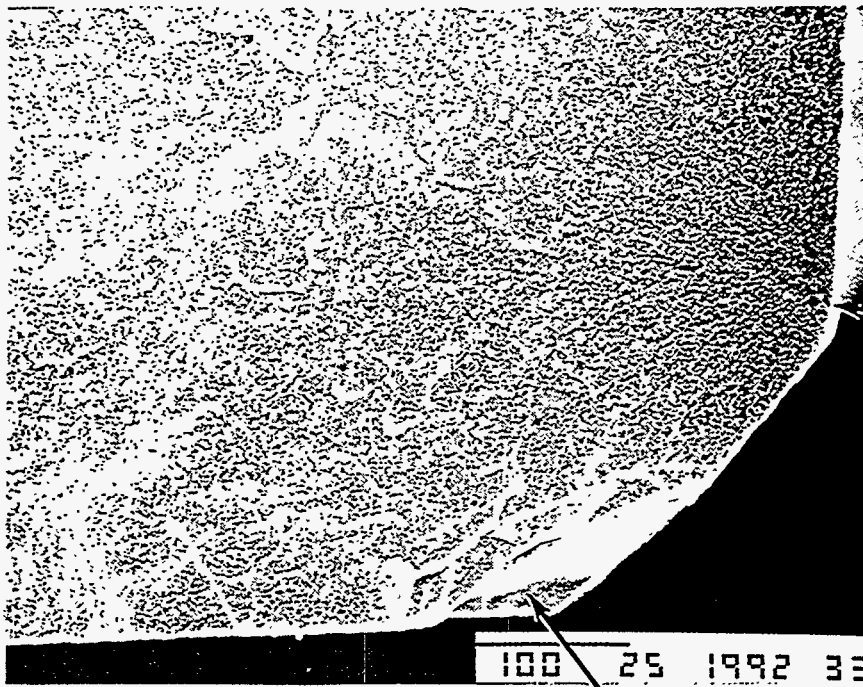
Oxidation Time: 1 hr



Specimen Number: 34.2060
Oxidation Temperature: 1200°C

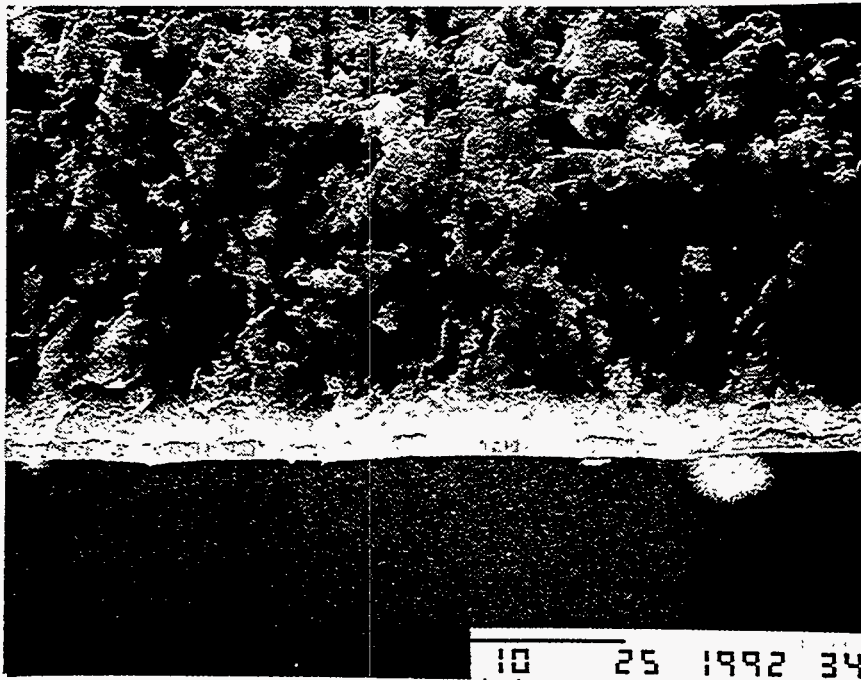
Oxidation Time: 1 hr





Specimen Number: 34.2051
Oxidation Temperature: 1200°C

Oxidation Time: 3 hr



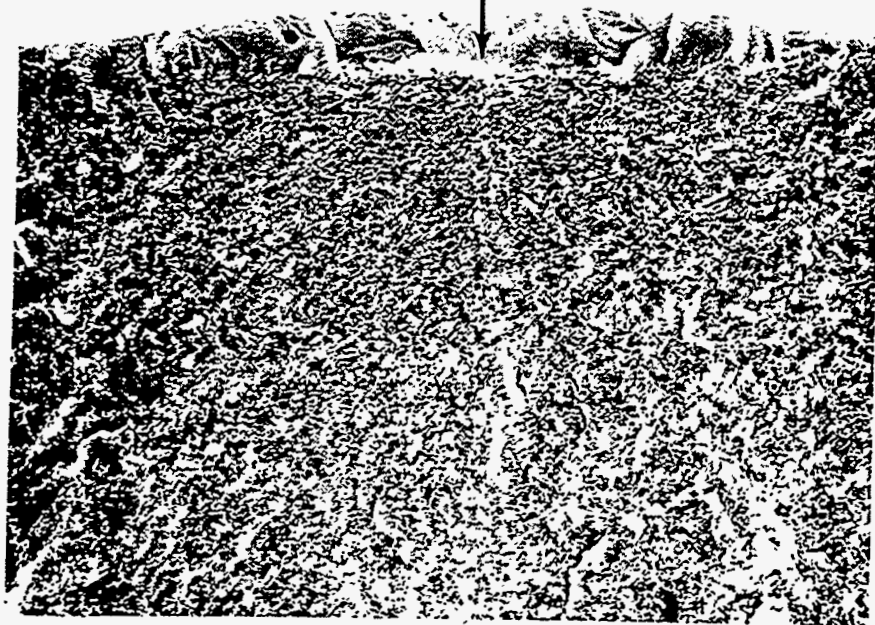
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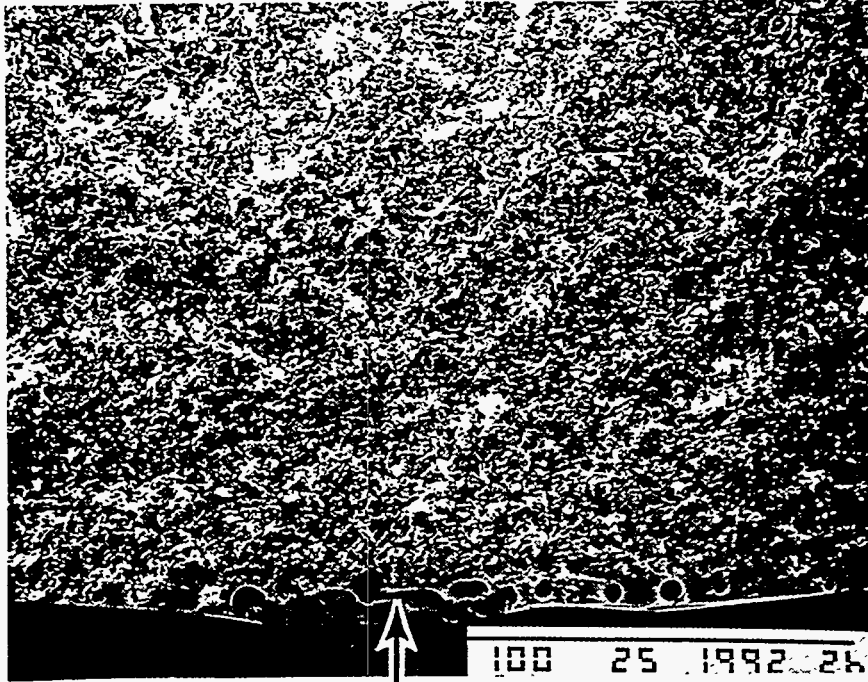


Specimen Number: 34.2052
Oxidation Temperature: 1200°C

Oxidation Time: 3 hr

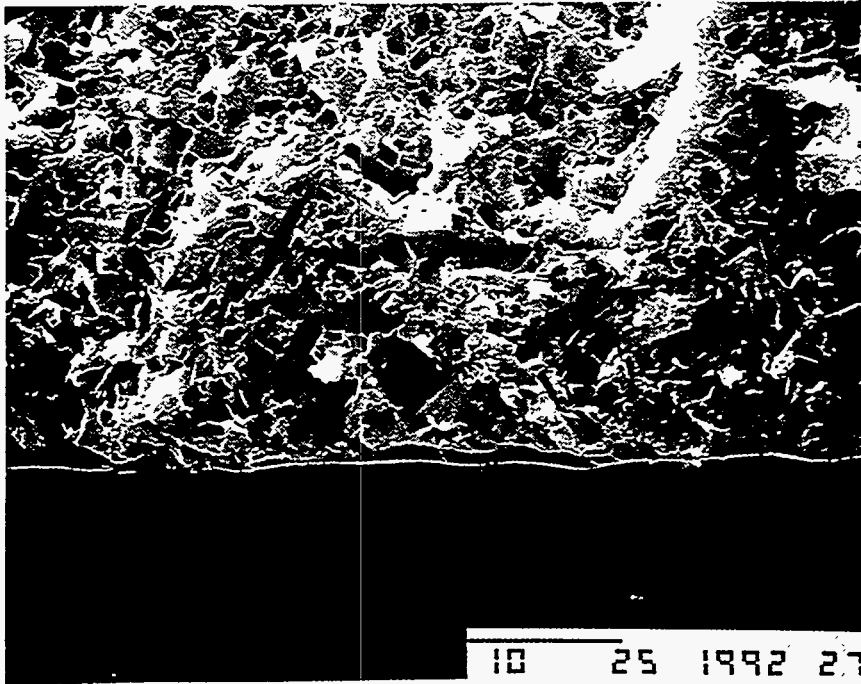
100 25 1992 35

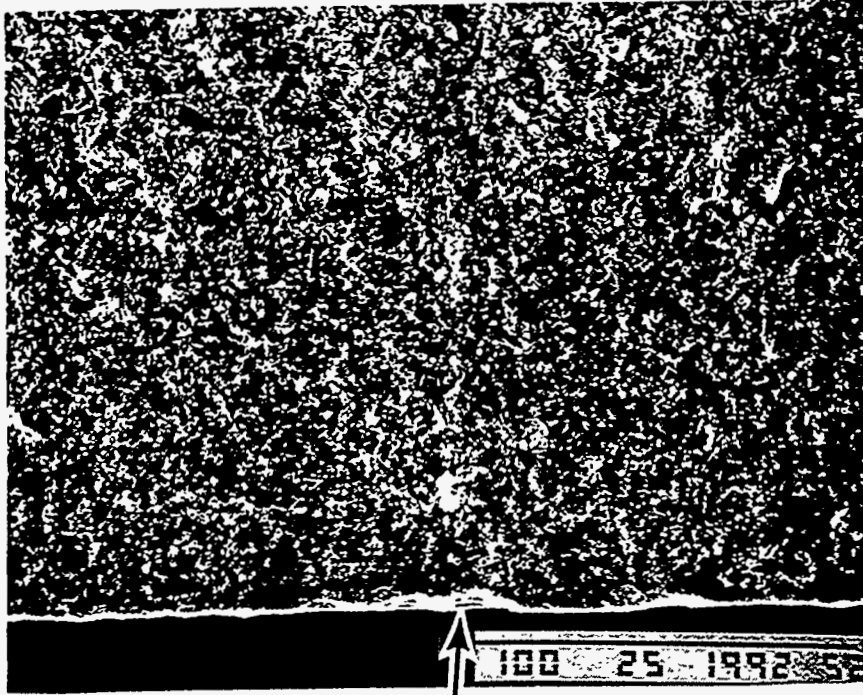




Specimen Number: 34.2053
Oxidation Temperature: 1200°C

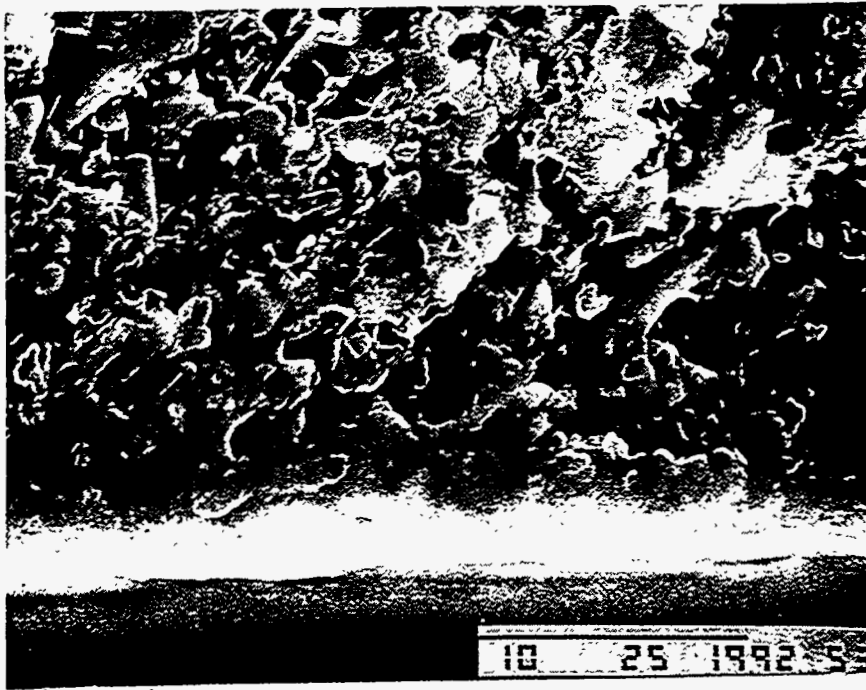
Oxidation Time: 3 hr

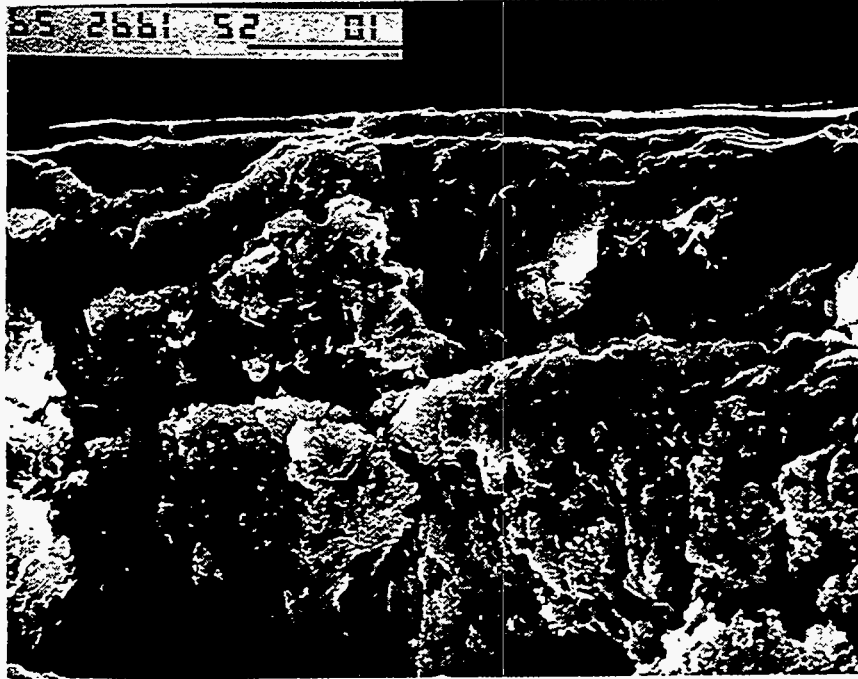




Specimen Number: 34.2056
Oxidation Temperature: 1200°C

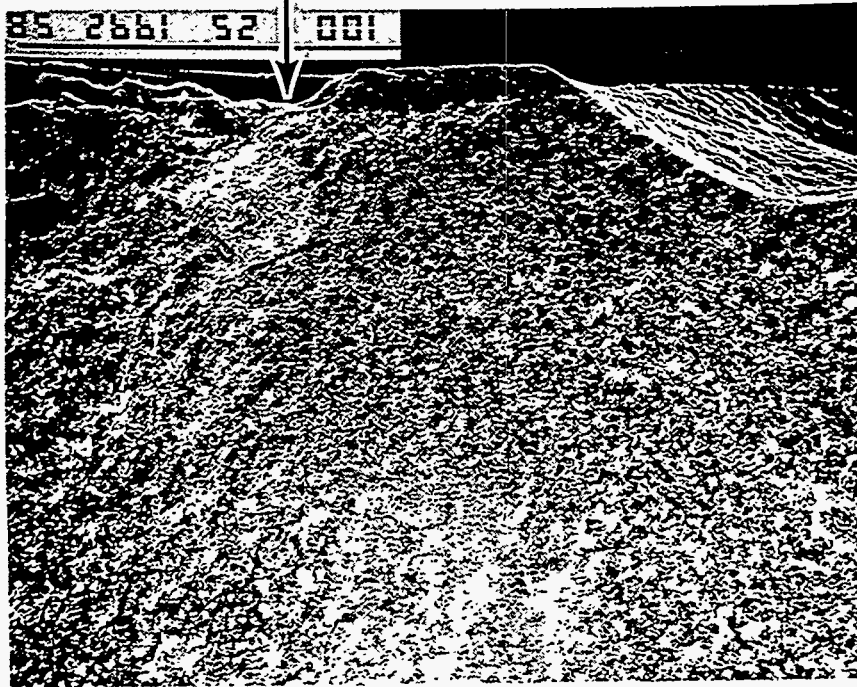
Oxidation Time: 6 hr

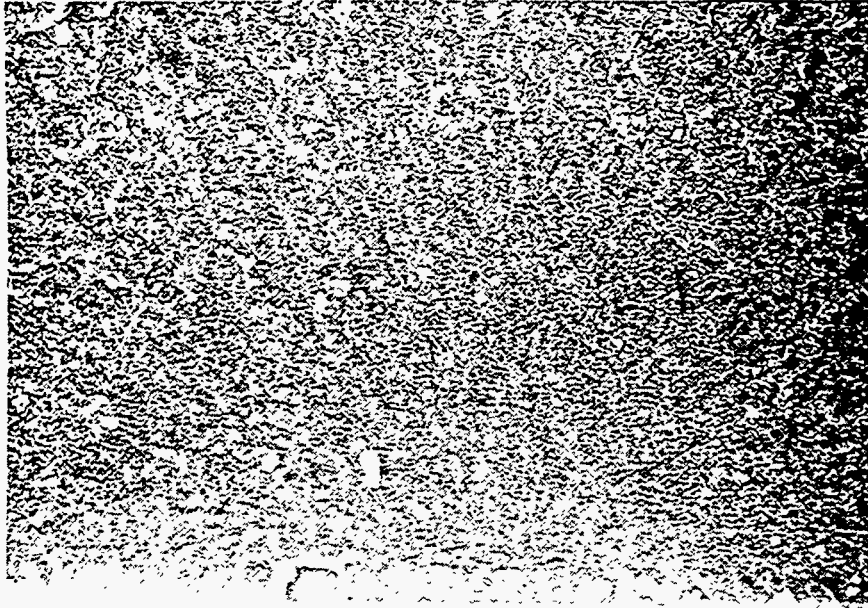




Specimen Number: 34.2055
Oxidation Temperature: 1200°C

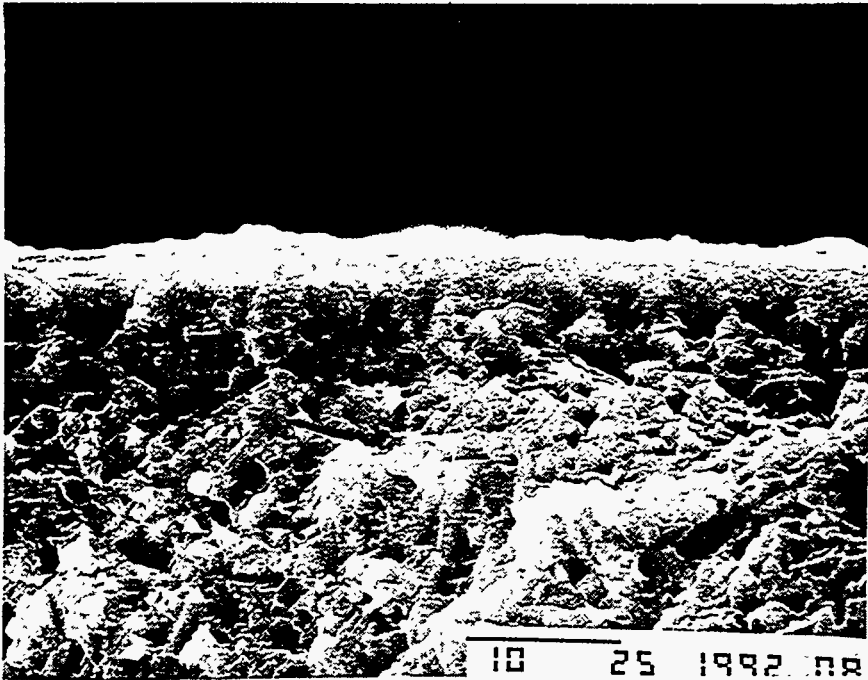
Oxidation Time: 3 hr

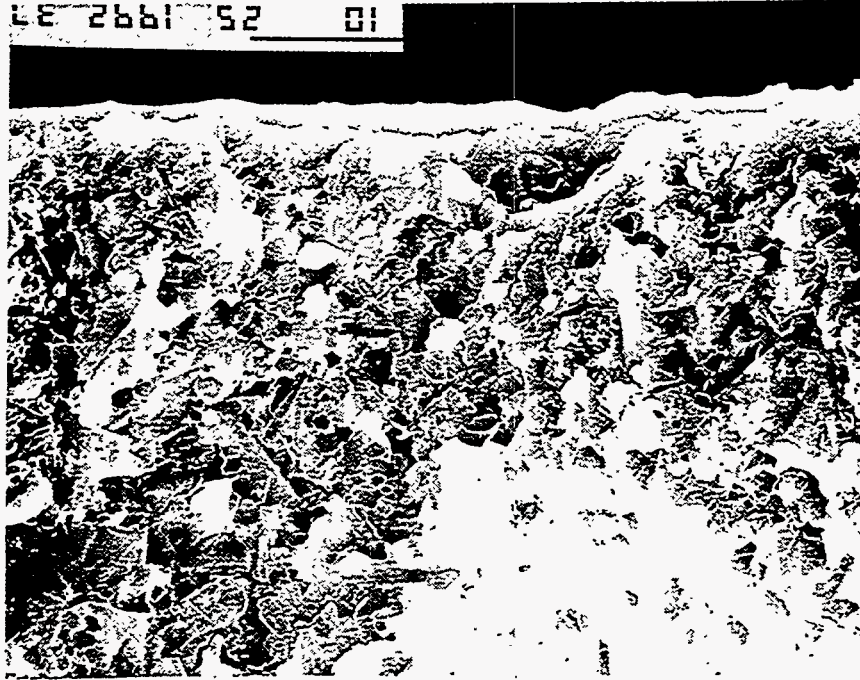




Specimen Number: 34.2047
Oxidation Temperature: 1200°C

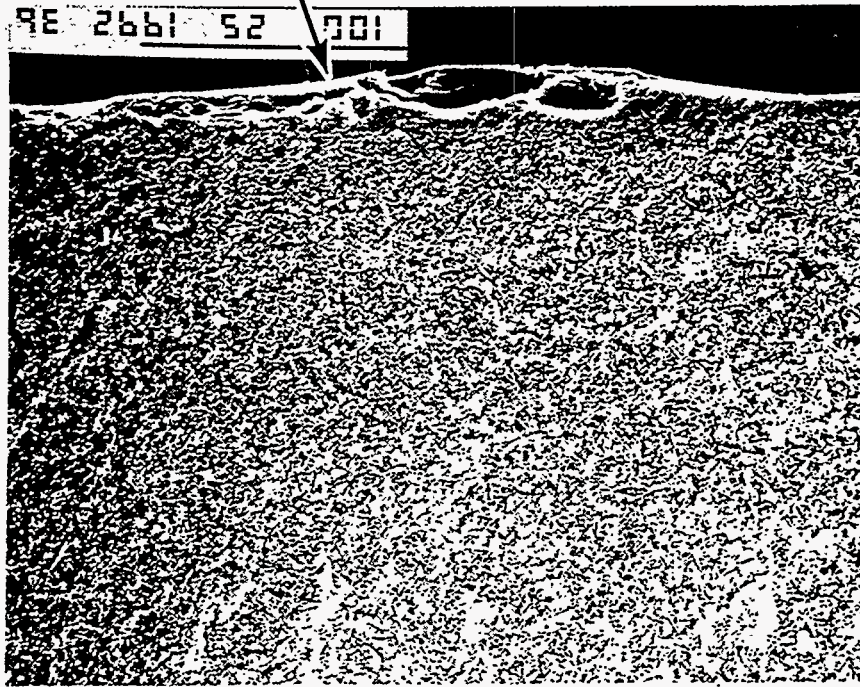
Oxidation Time: 6 hr

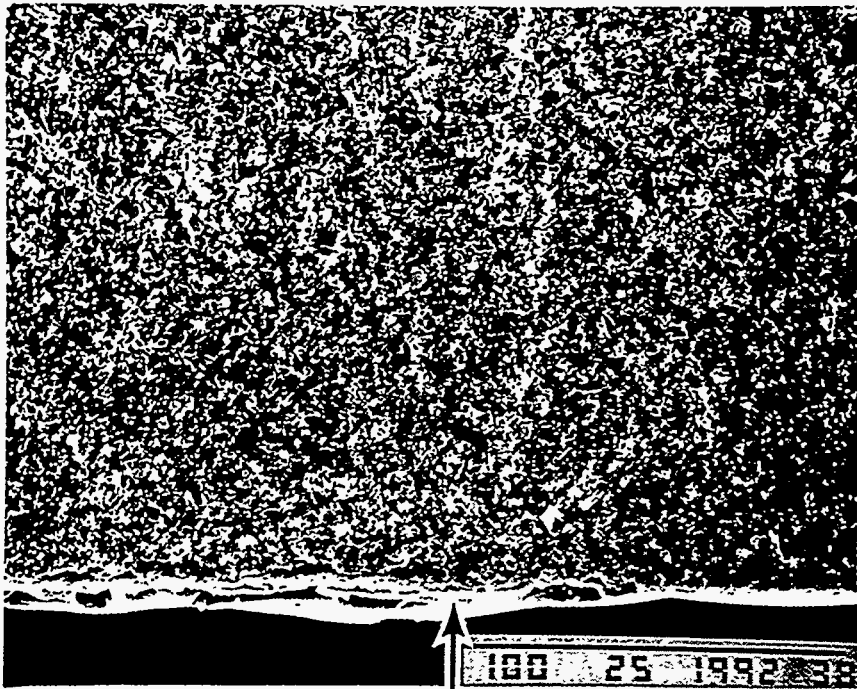




Oxidation Time: 6 hr

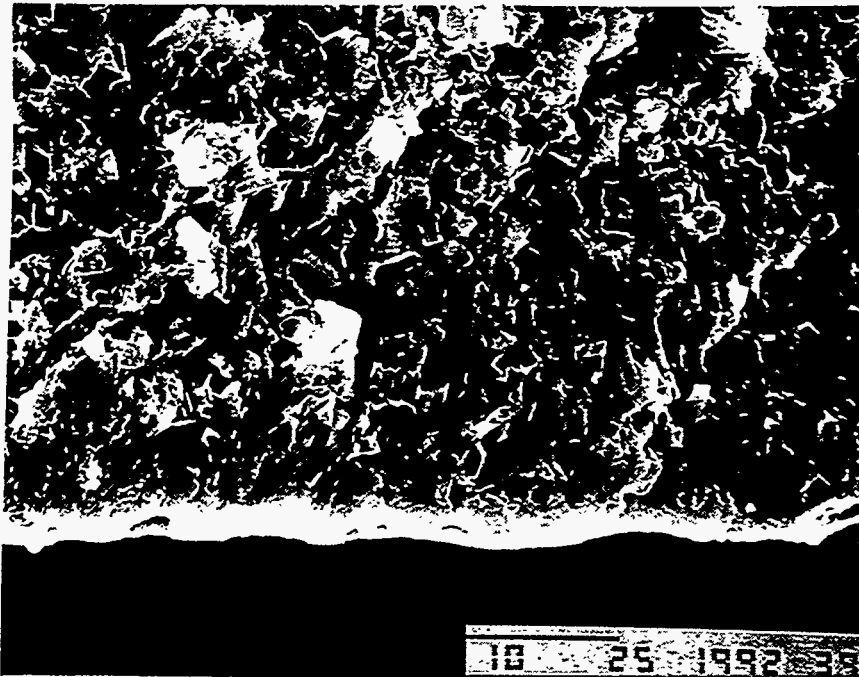
Specimen Number: 34.2048
Oxidation Temperature: 1200°C

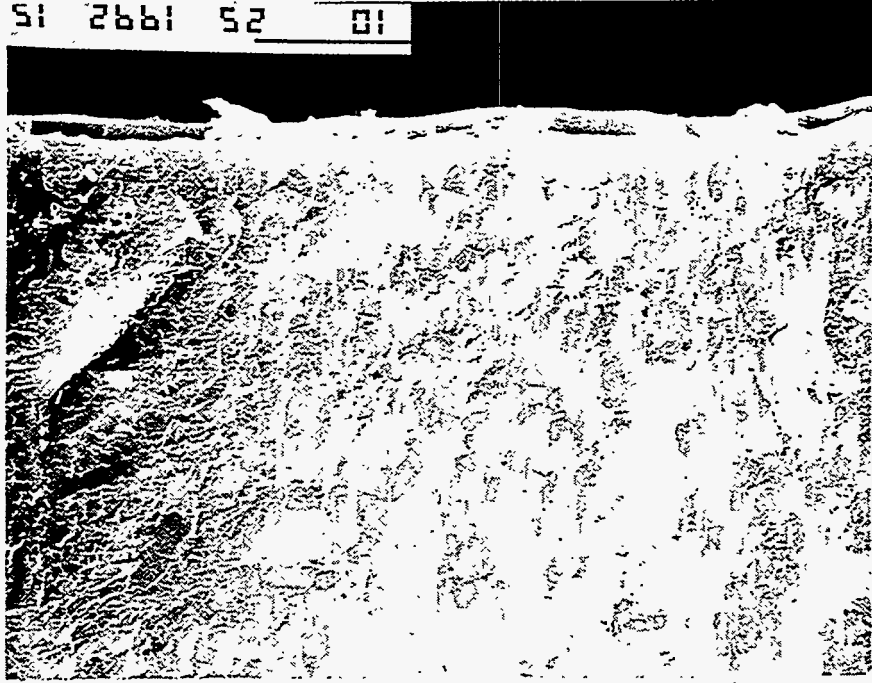




Specimen Number: 34.2049
Oxidation Temperature: 1200°C

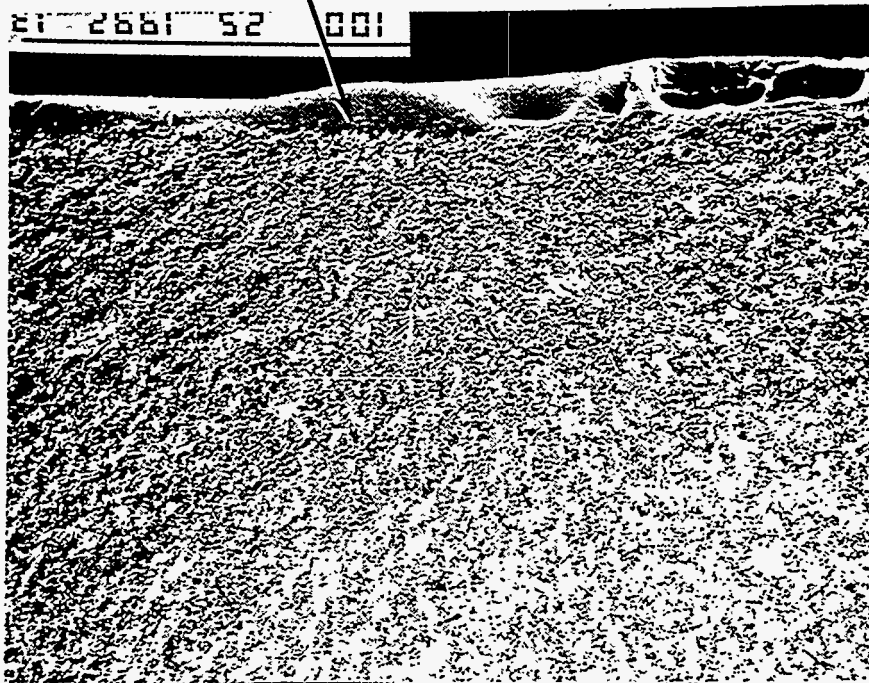
Oxidation Time: 6 hr

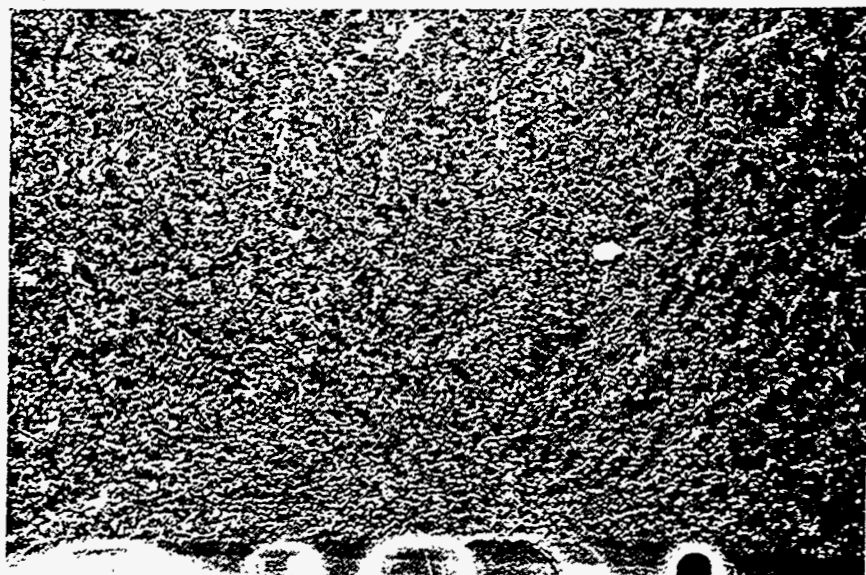




Oxidation Time: 6 hr

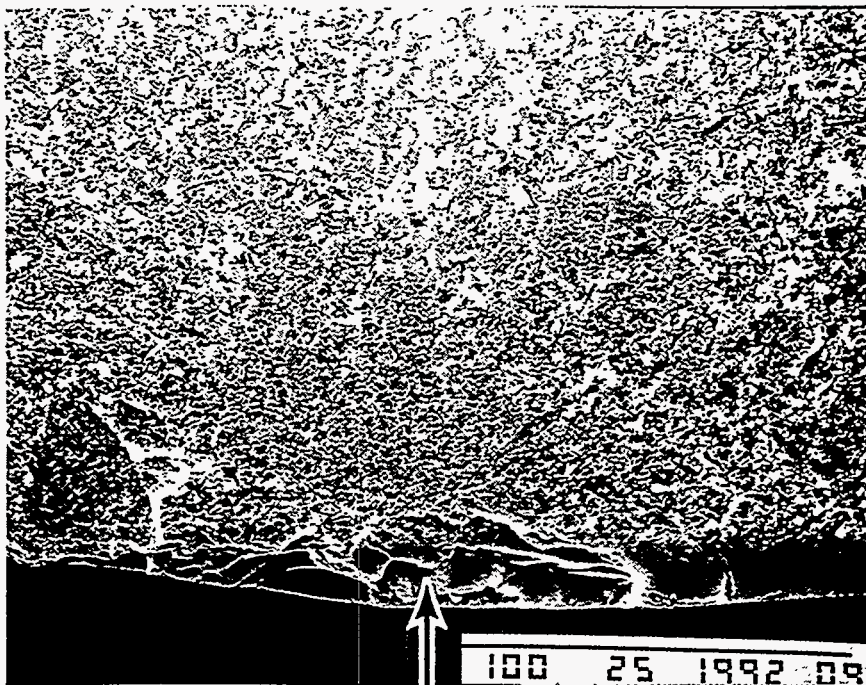
Specimen Number: 34.2050
Oxidation Temperature: 1200°C





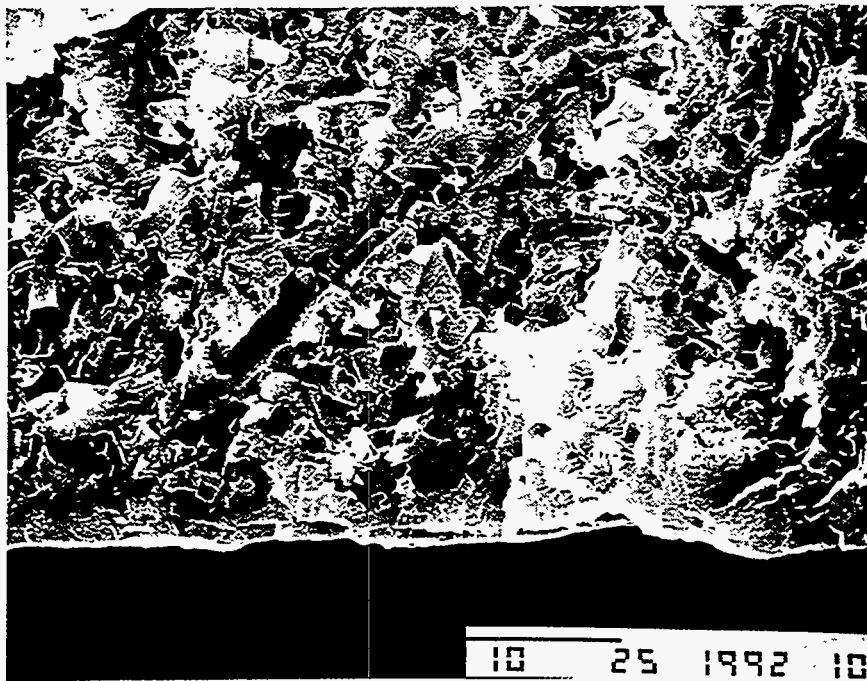
Specimen Number: 34.2041
Oxidation Temperature: 1200°C

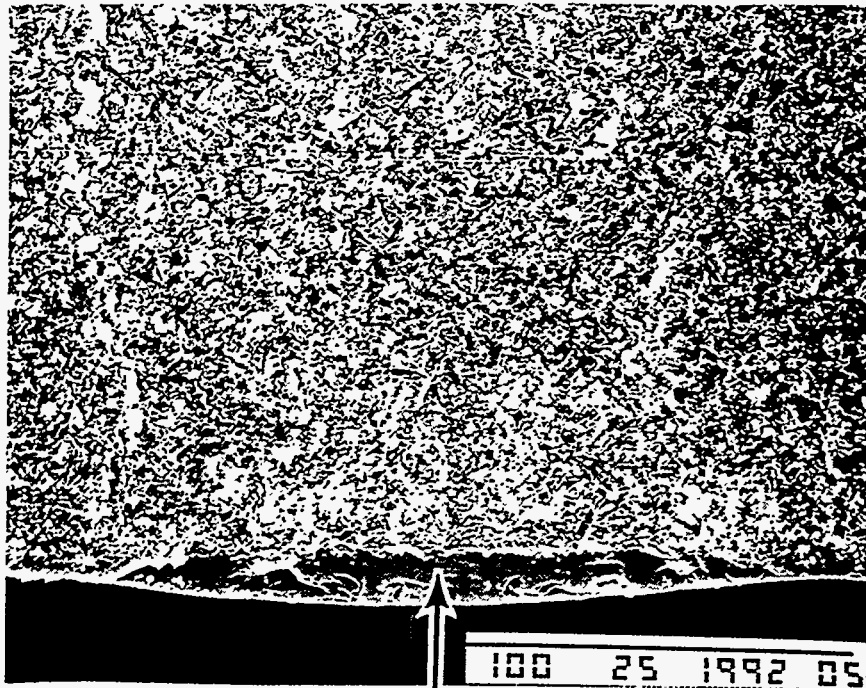
Oxidation Time: 10 hr



Specimen Number: 34.2042
Oxidation Temperature: 1200°C

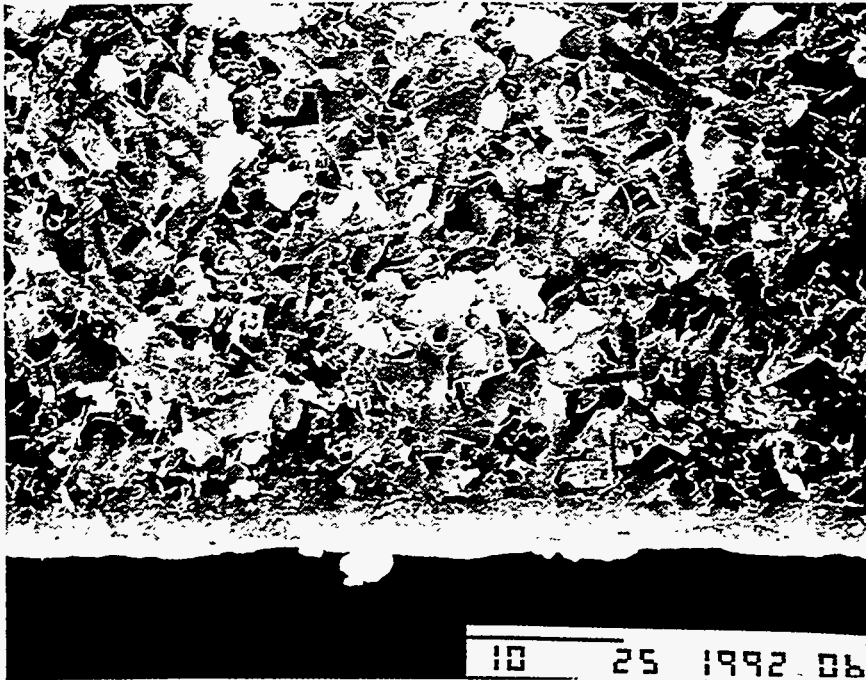
Oxidation Time: 10 hr

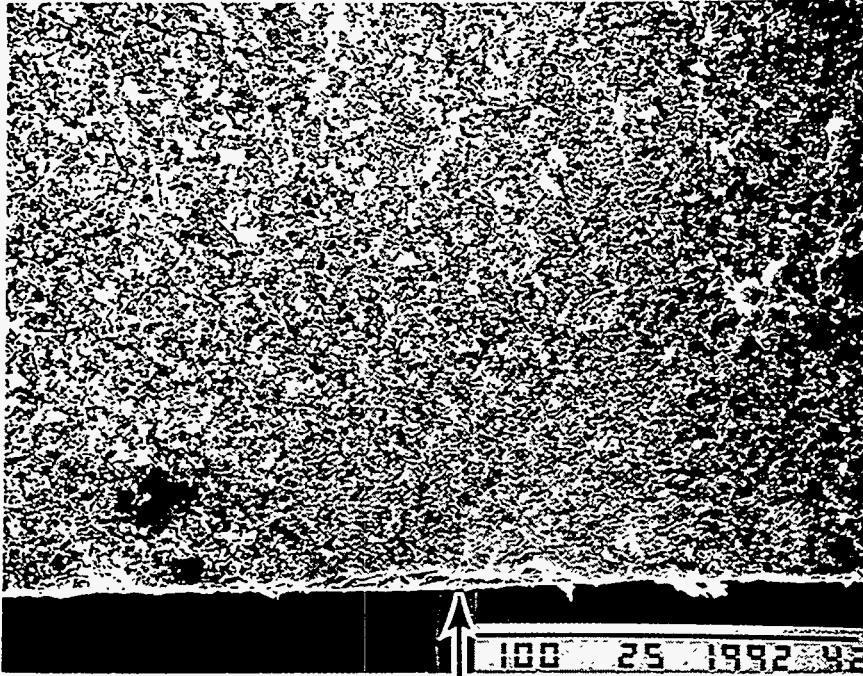




Specimen Number: 34.2043
Oxidation Temperature: 1200°C

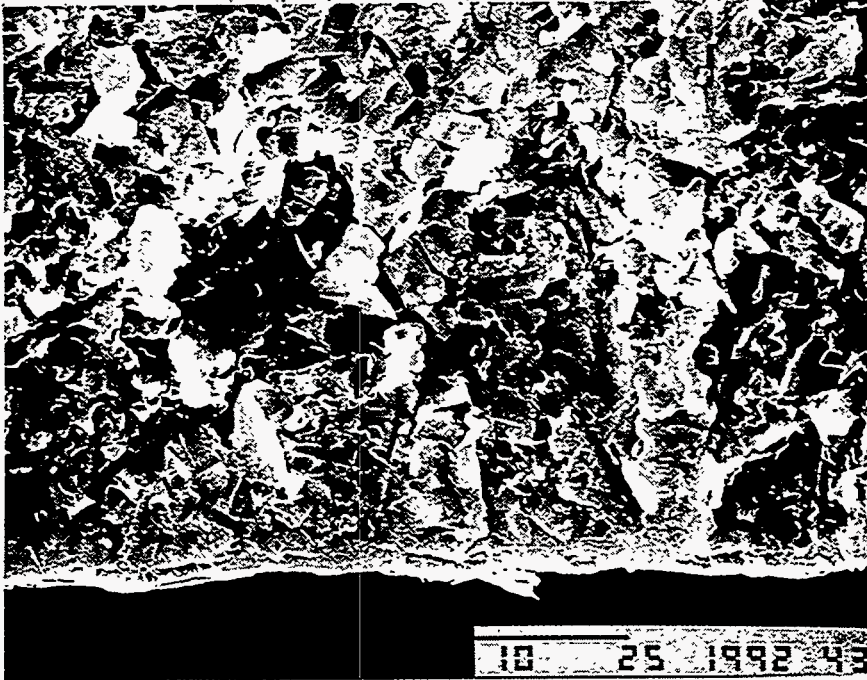
Oxidation Time: 10 hr

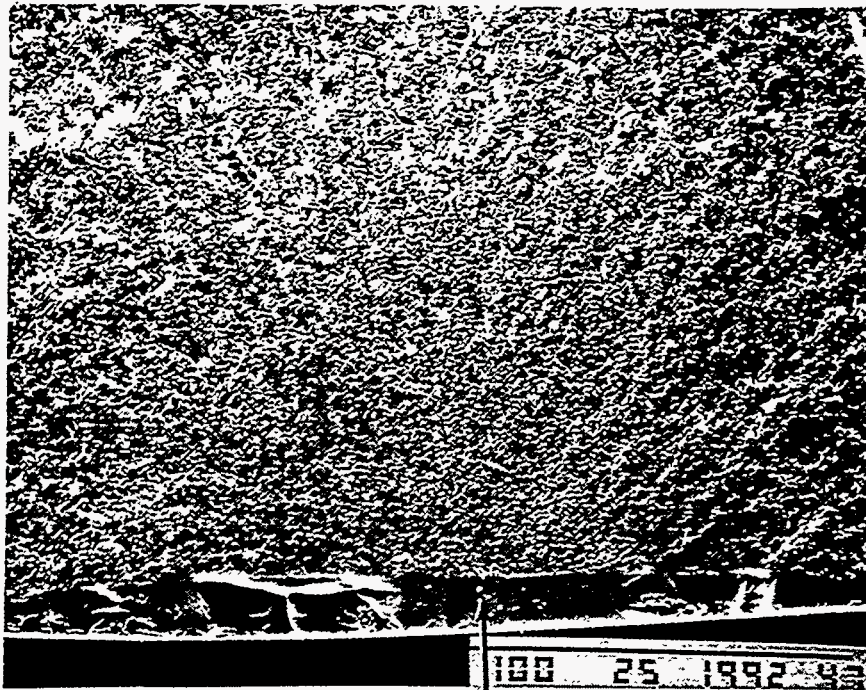




Specimen Number: 34.2044
Oxidation Temperature: 1200°C

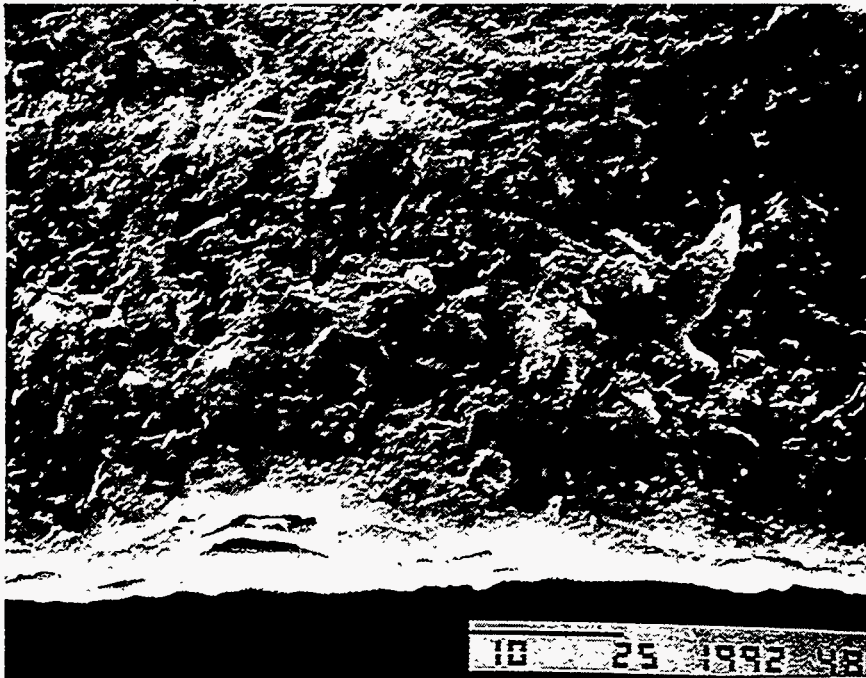
Oxidation Time: 10 hr

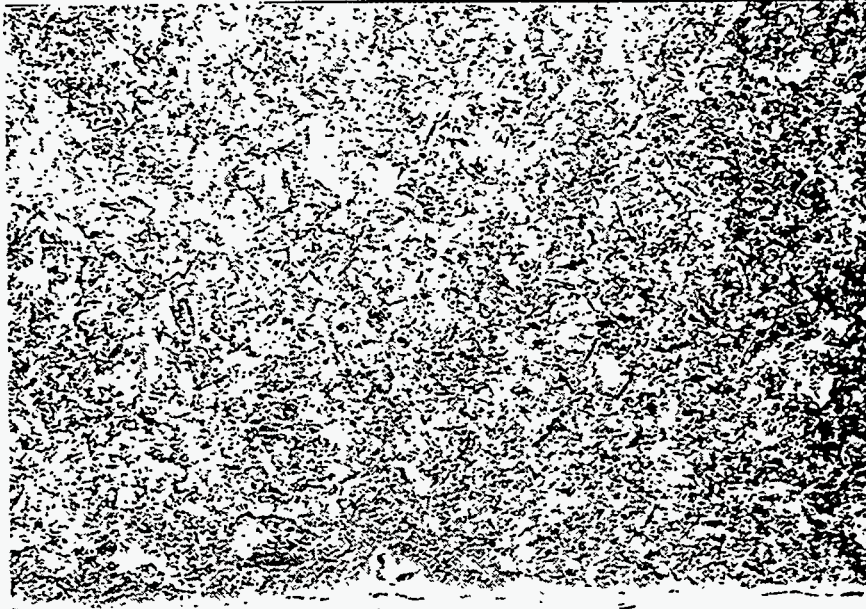




Specimen Number: 34.2045
Oxidation Temperature: 1200°C

Oxidation Time: 10 hr





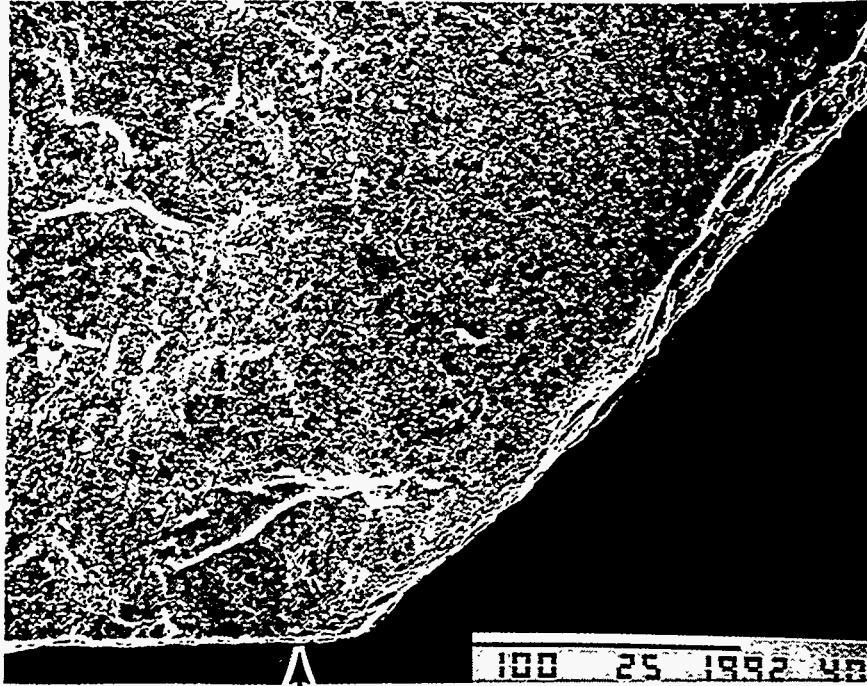
100 25 1992 02

Specimen Number: 34.1736
Oxidation Temperature: 1200°C

Oxidation Time: 50 hr

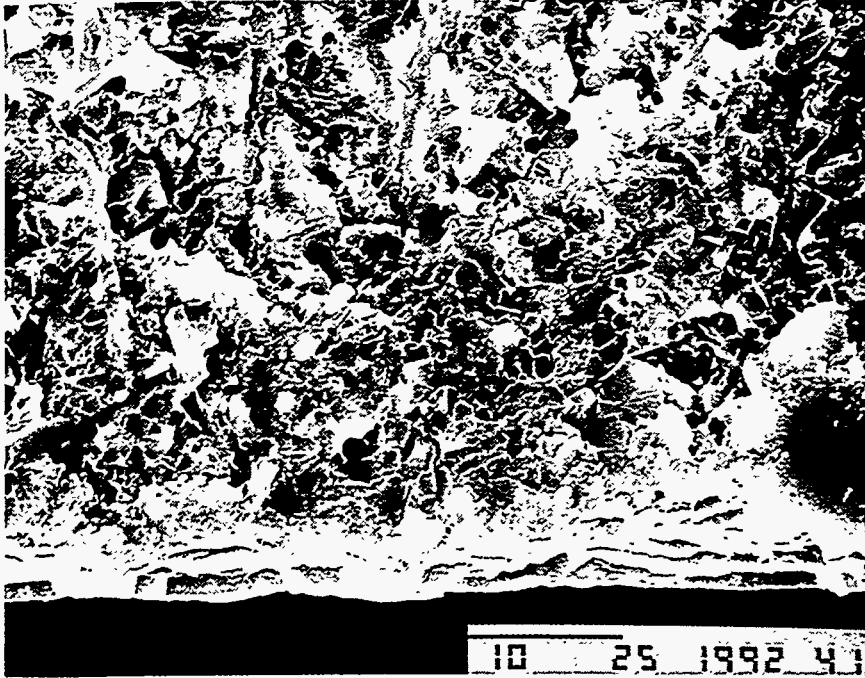


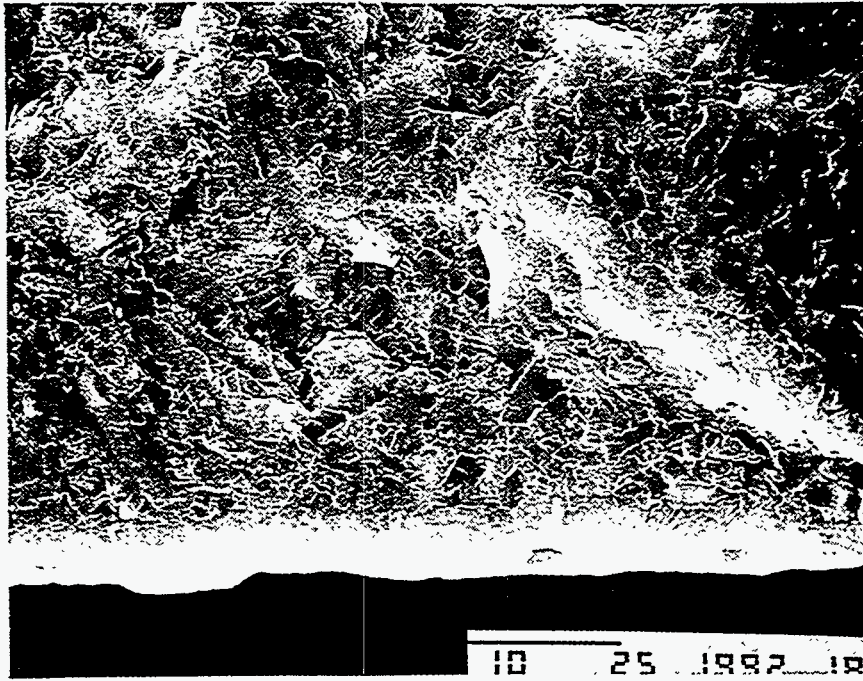
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Specimen Number: 34.1738
Oxidation Temperature: 1200°C

Oxidation Time: 50 hr





Specimen Number: 34.1739

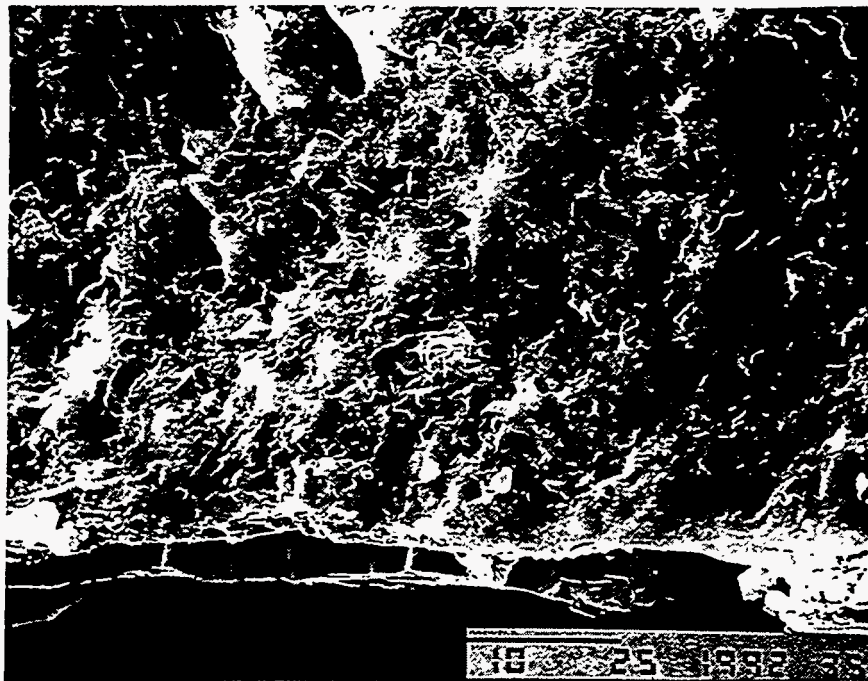
Oxidation Temperature: 1200°C

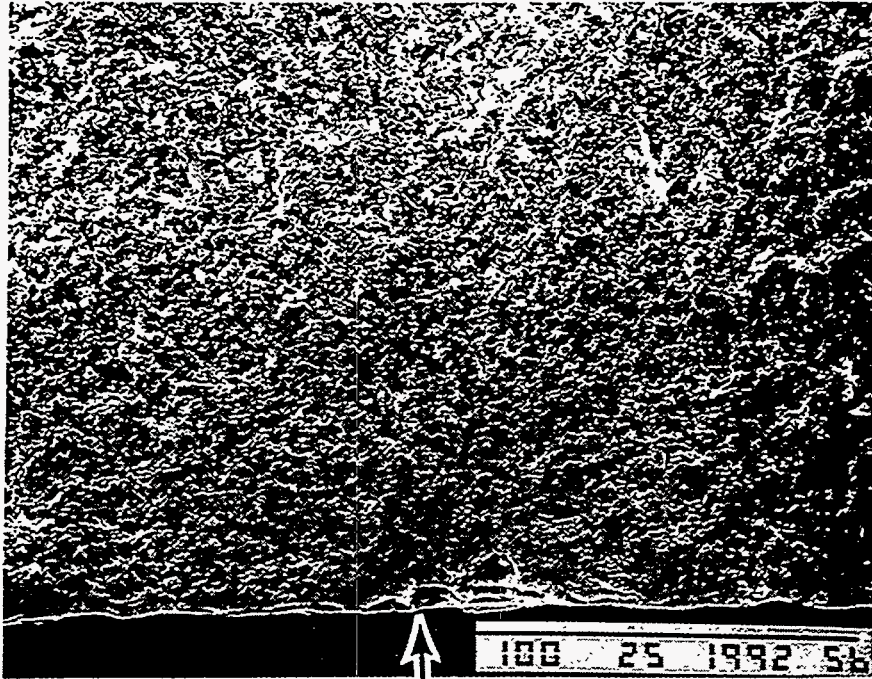
Oxidation Time: 50 hr



Specimen Number: 34.1740
Oxidation Temperature: 1200°C

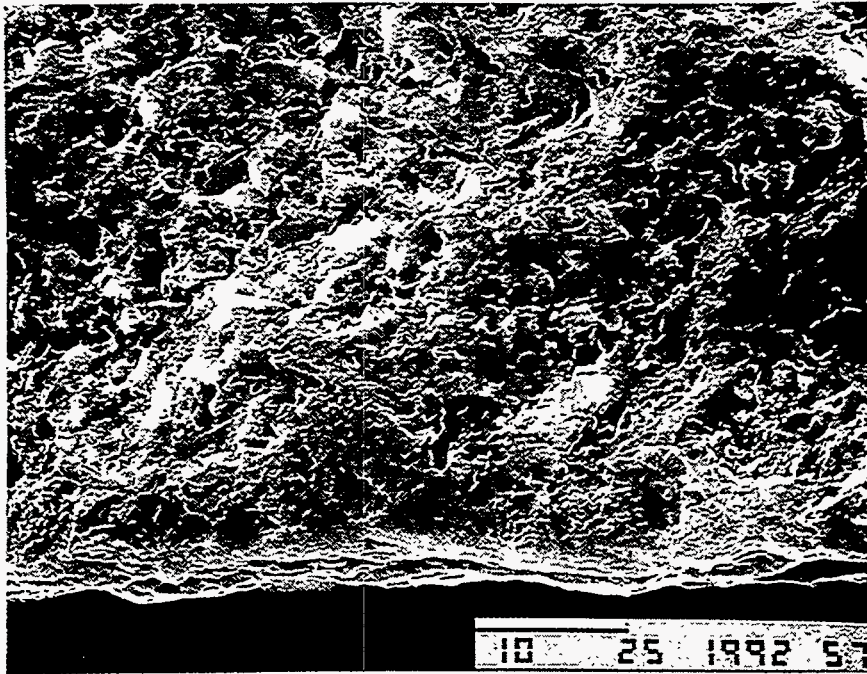
Oxidation Time: 50 hr

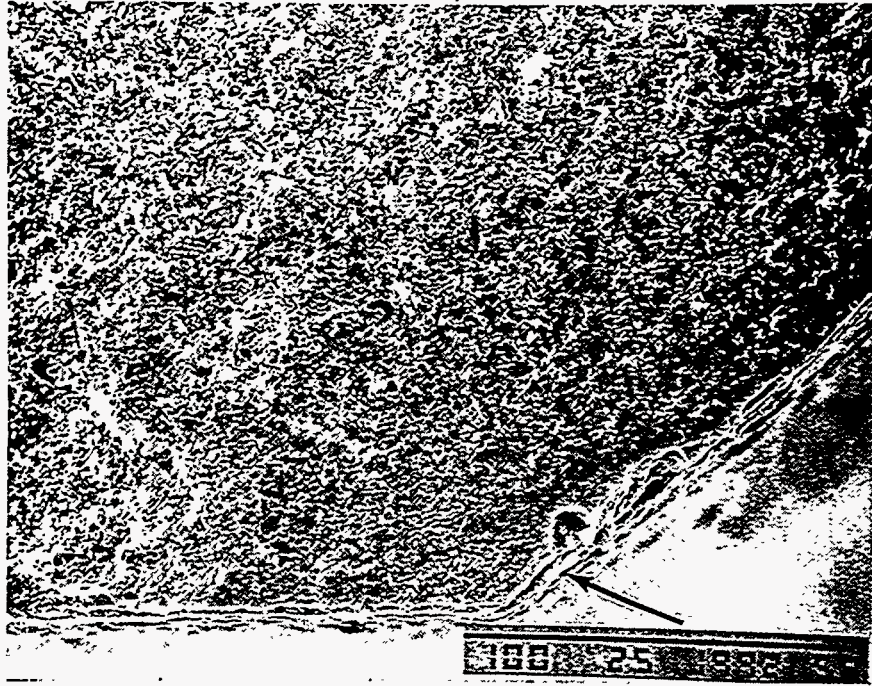




Specimen Number: 34.1741
Oxidation Temperature: 1200°C

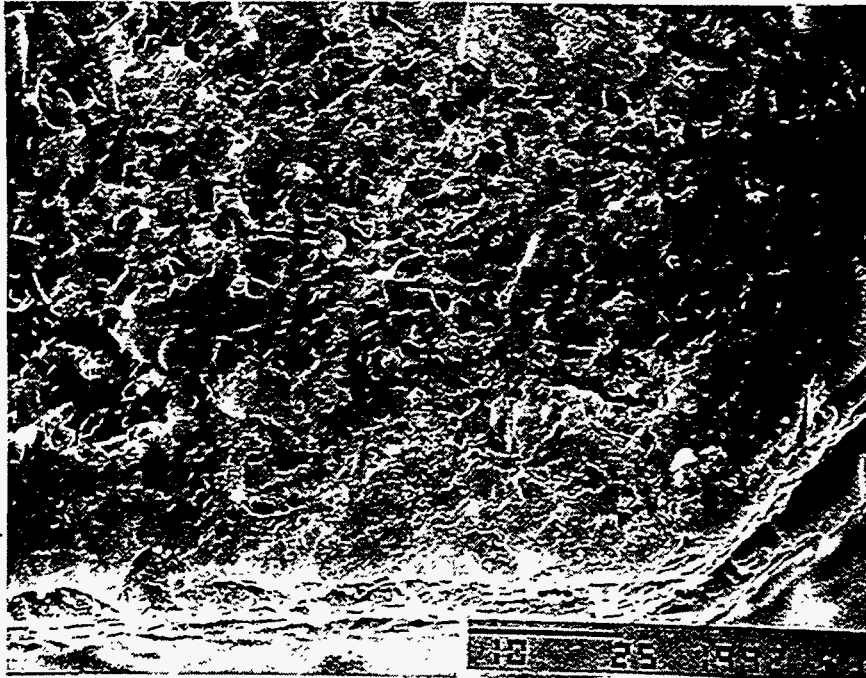
Oxidation Time: 50 hr

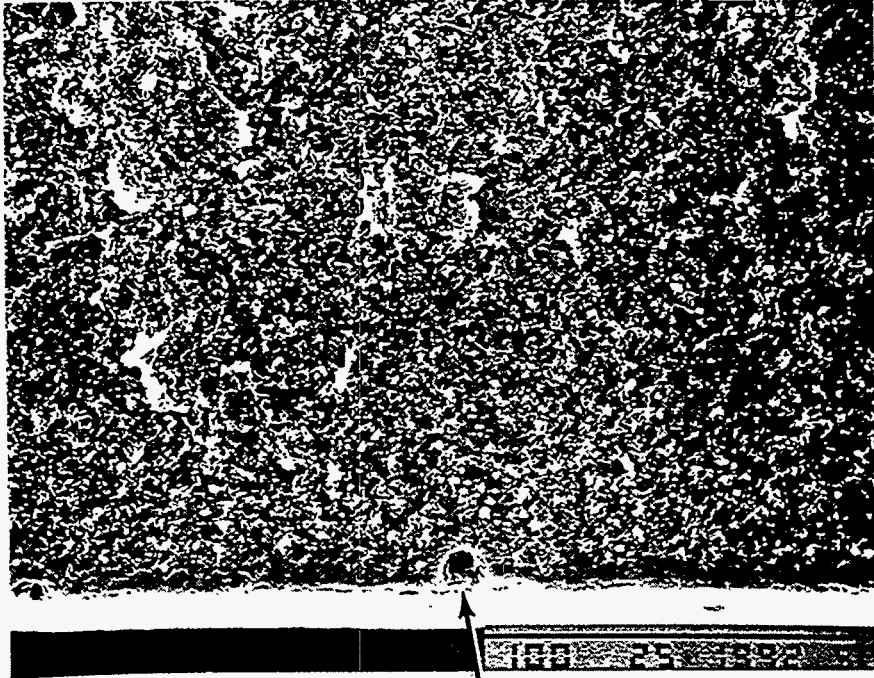




Specimen Number: 34.1568
Oxidation Temperature: 1200°C

Oxidation Time: 100 hr

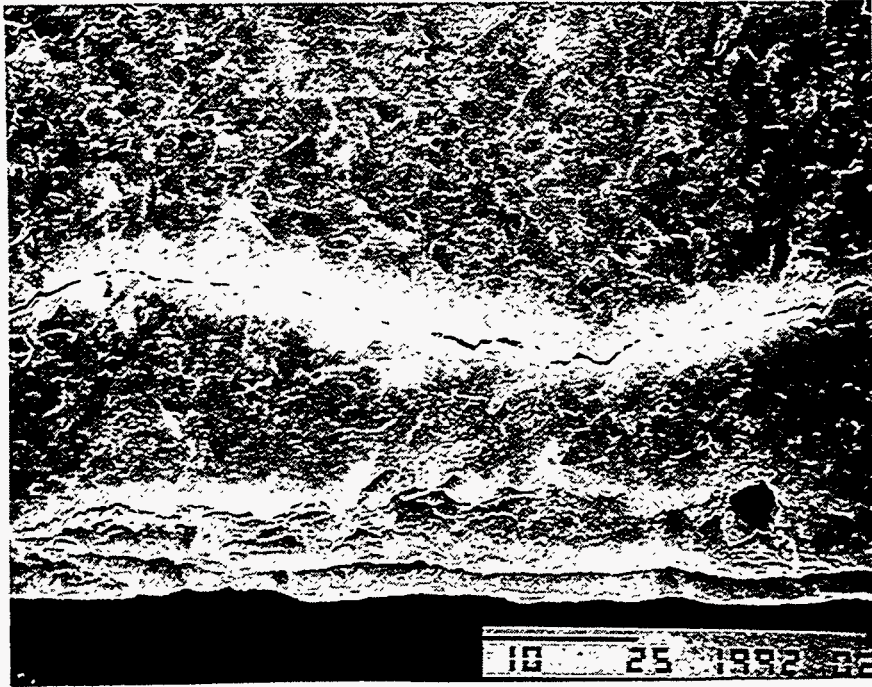




Specimen Number: 34.1569
Oxidation Temperature: 1200°C

Oxidation Time: 100 hr





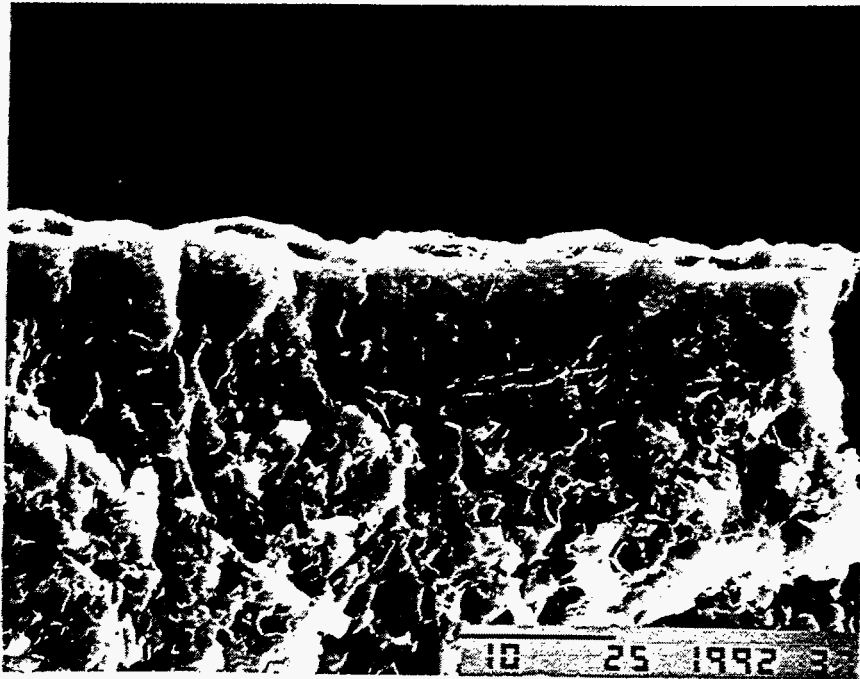
Specimen Number: 34.1567
Oxidation Temperature: 1200°C

Oxidation Time: 100 hr



Specimen Number: 34.1570
Oxidation Temperature: 1200°C

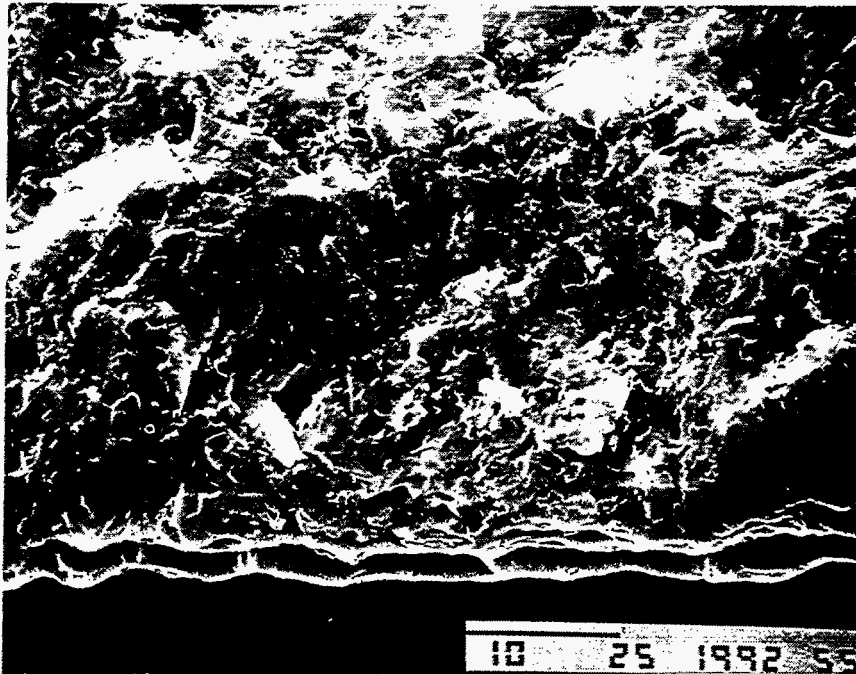
Oxidation Time: 100 hr

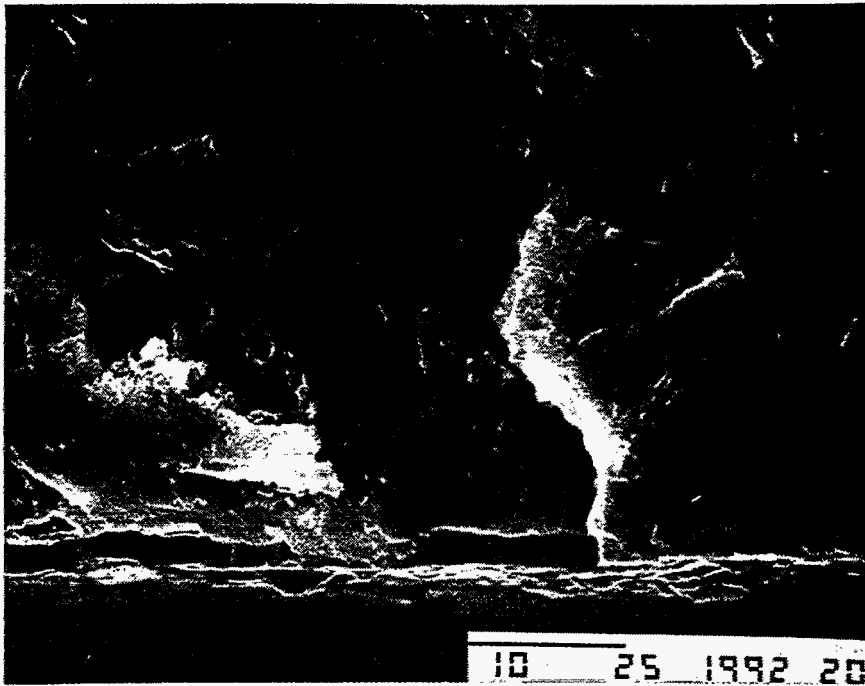


Specimen Number: 34.1813

Oxidation Temperature: 1200°C

Oxidation Time: 200 hr

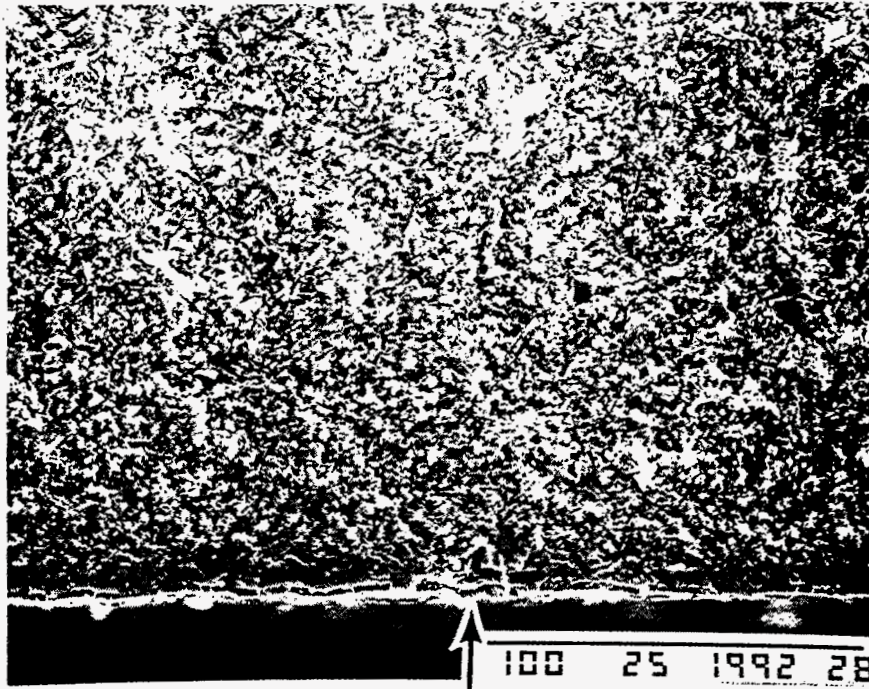




Specimen Number: 34.1815

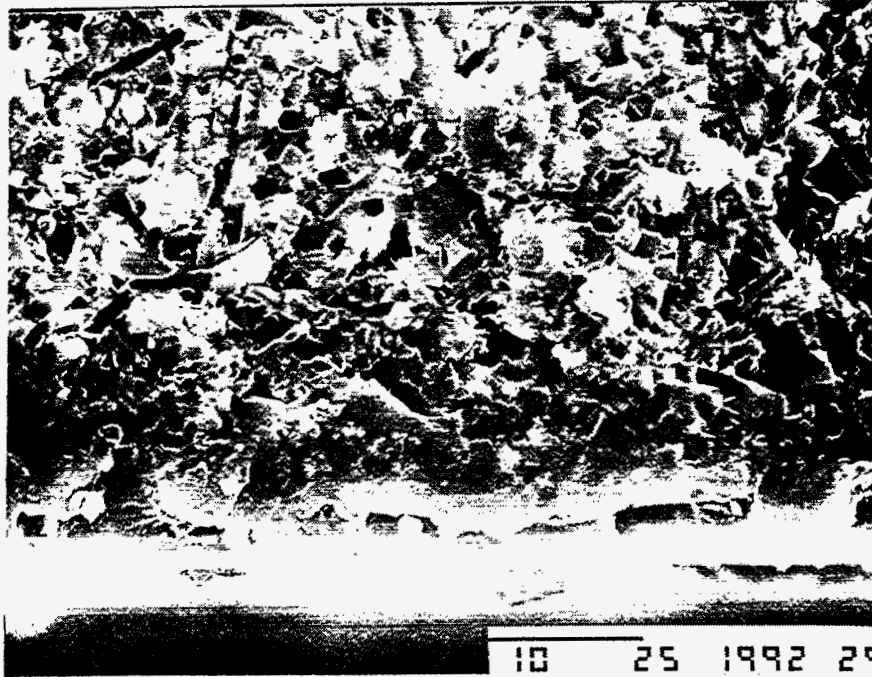
Oxidation Temperature: 1200°C

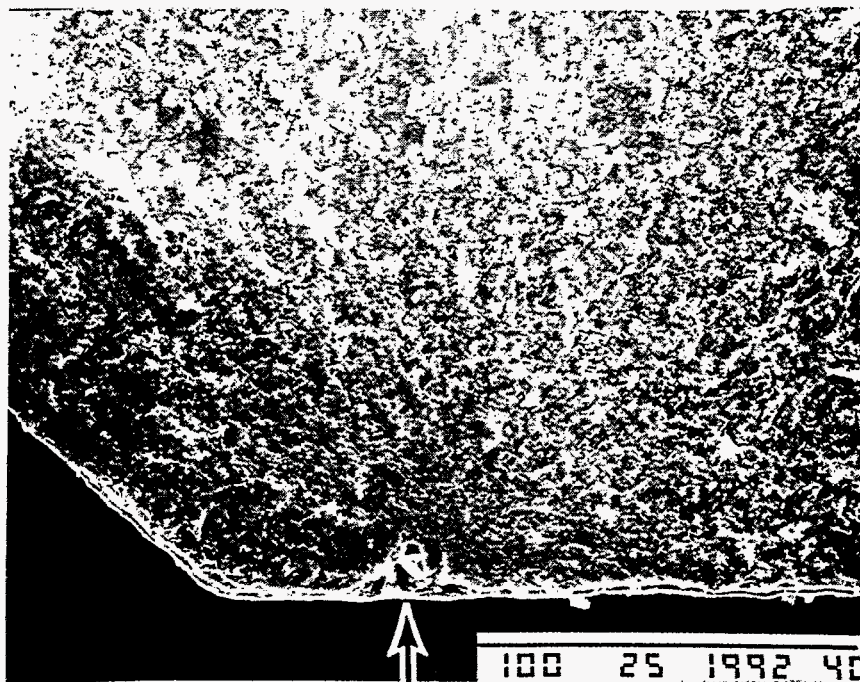
Oxidation Time: 200 hr



Specimen Number: 34.1816
Oxidation Temperature: 1200°C

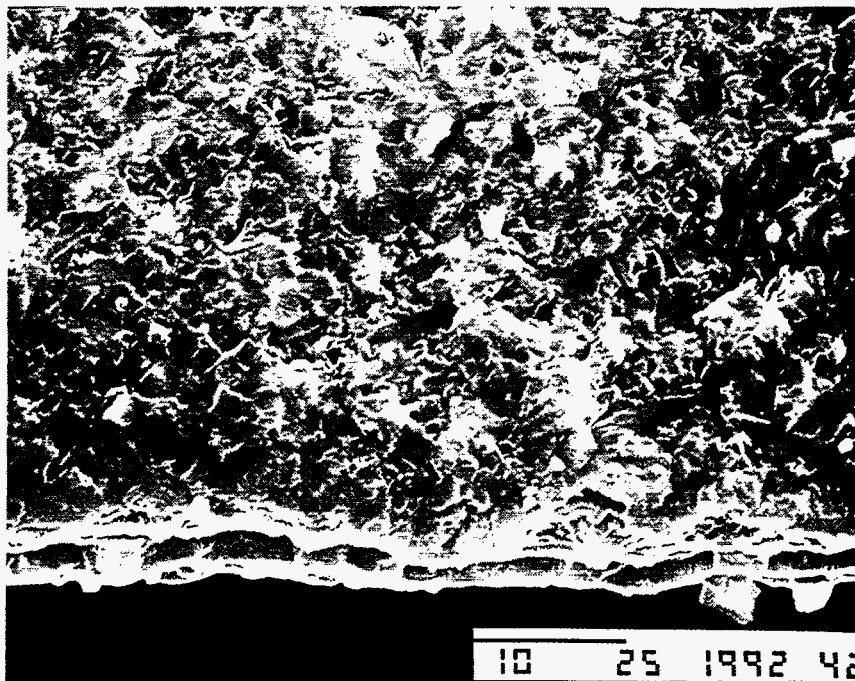
Oxidation Time: 200 hr

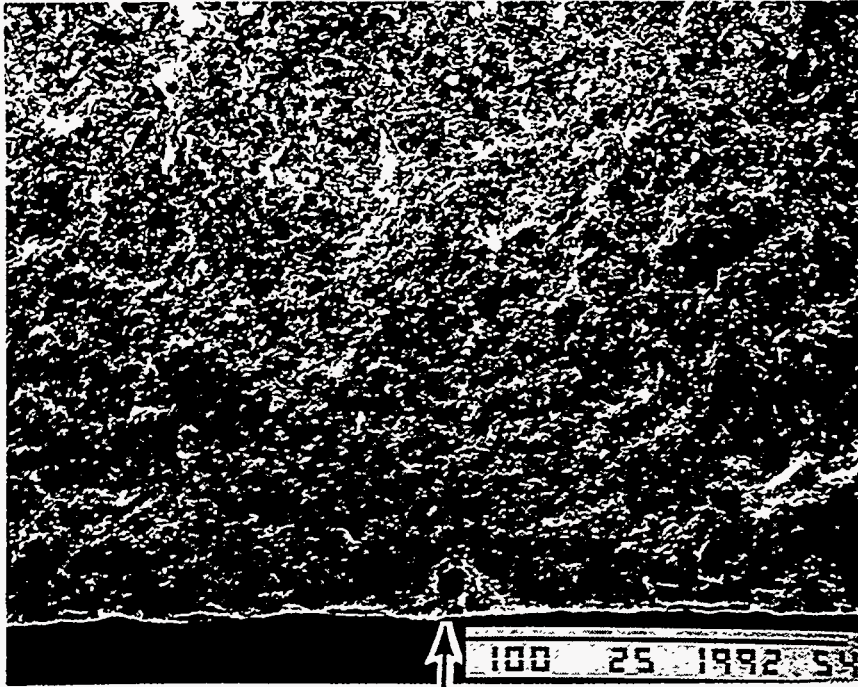




Specimen Number: 34.1817
Oxidation Temperature: 1200°C

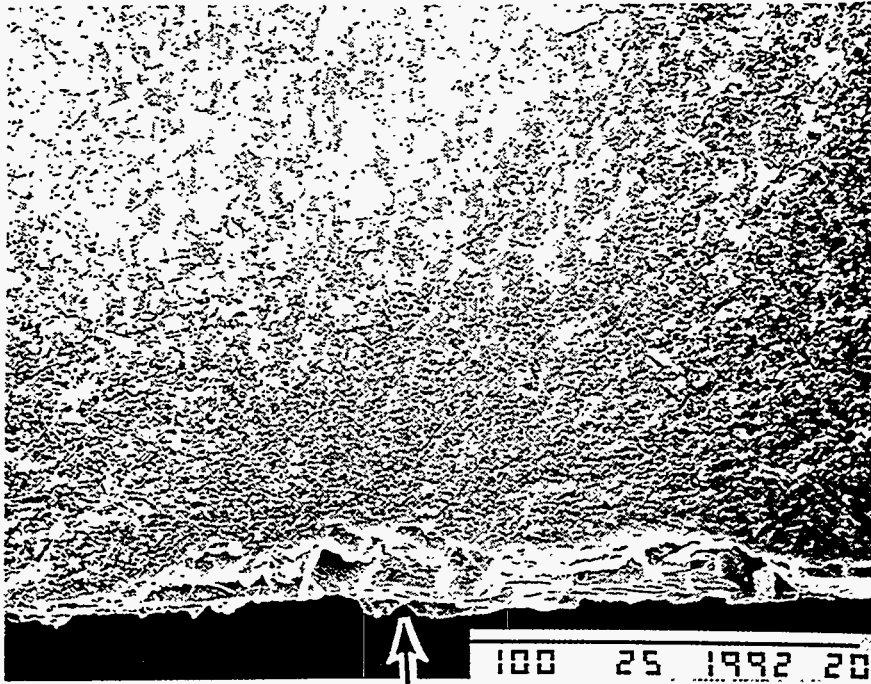
Oxidation Time: 200 hr





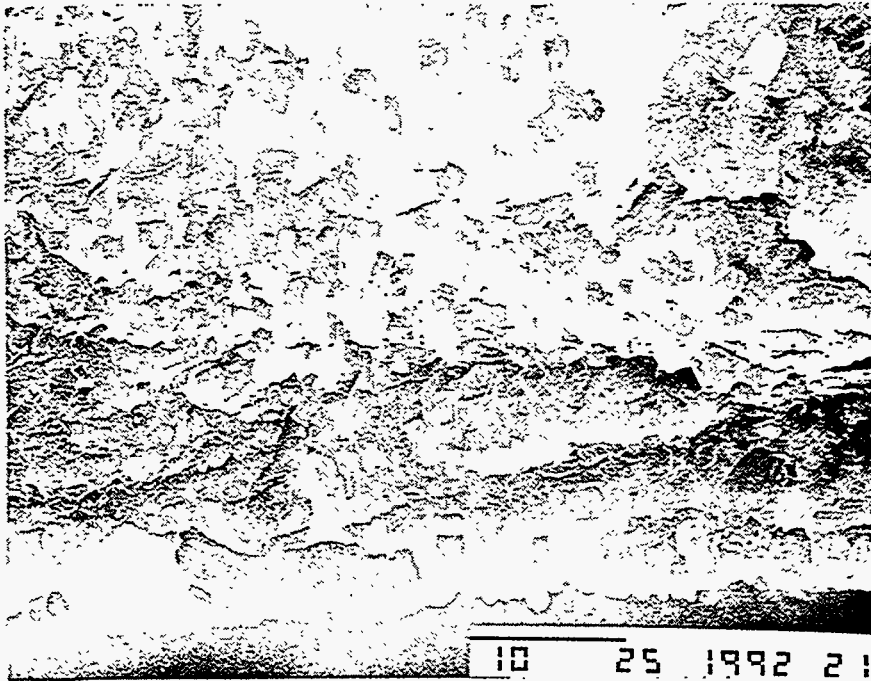
Specimen Number: 34.1818
Oxidation Temperature: 1200°C

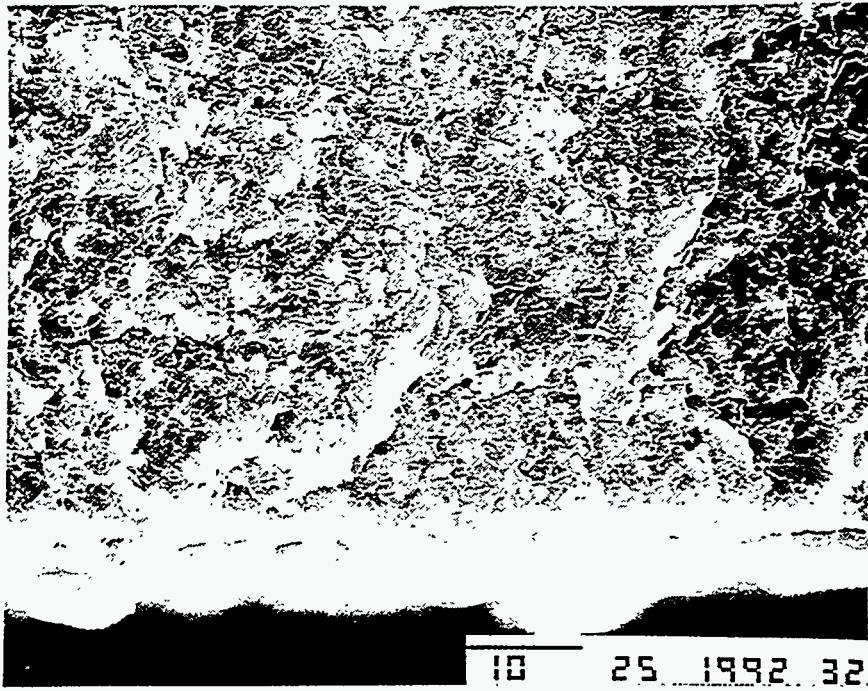
Oxidation Time: 500 hr



Specimen Number: 34.1819
Oxidation Temperature: 1200°C

Oxidation Time: 500 hr

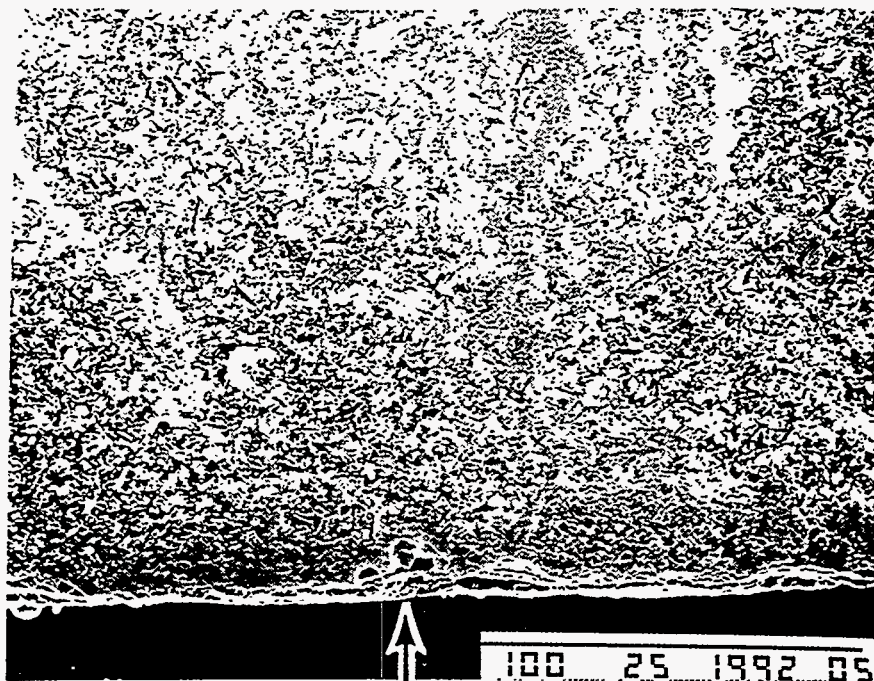




Specimen Number: 34.1821

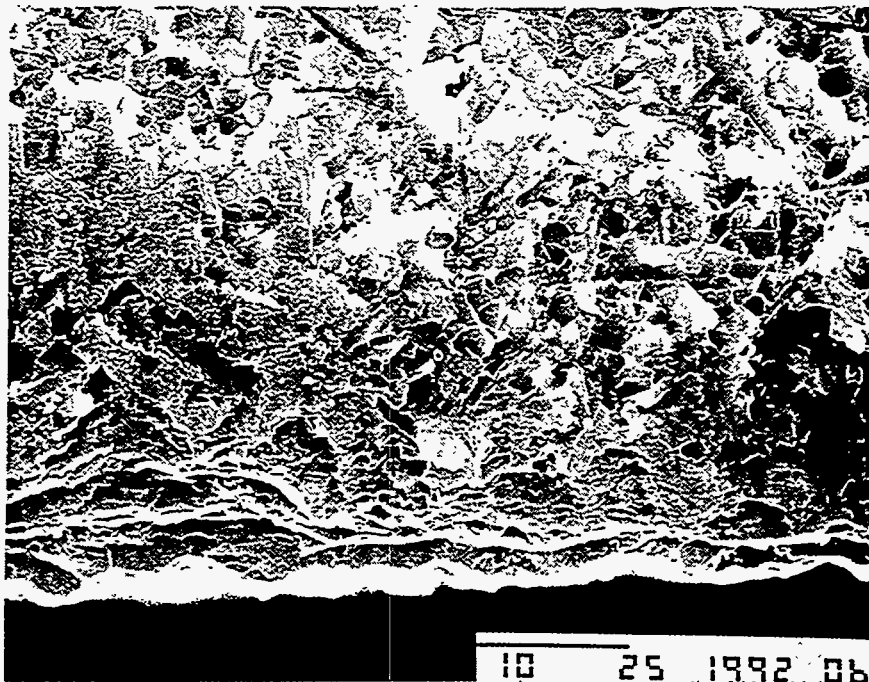
Oxidation Temperature: 1200°C

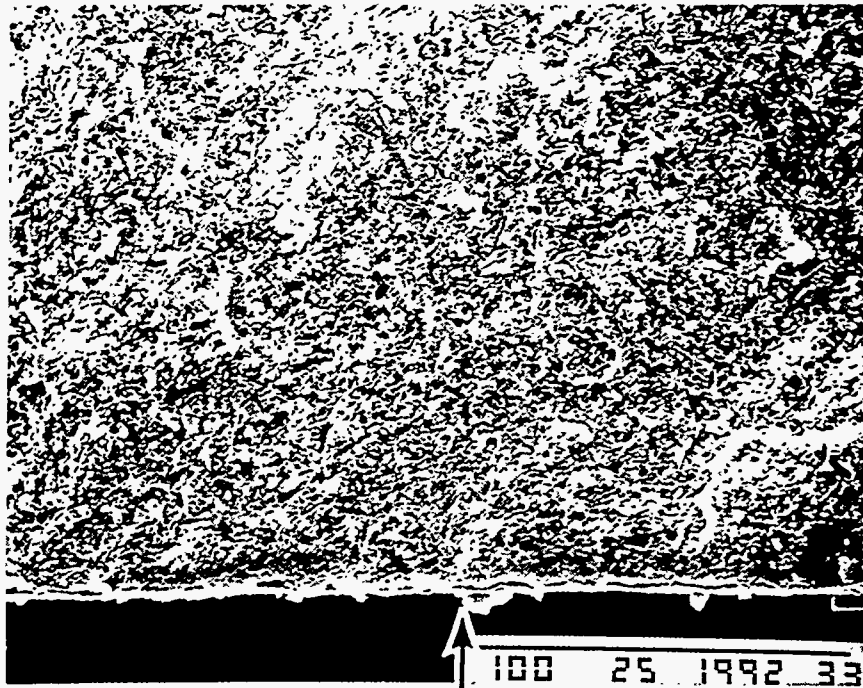
Oxidation Time: 500 hr



Specimen Number: 34.1822
Oxidation Temperature: 1200°C

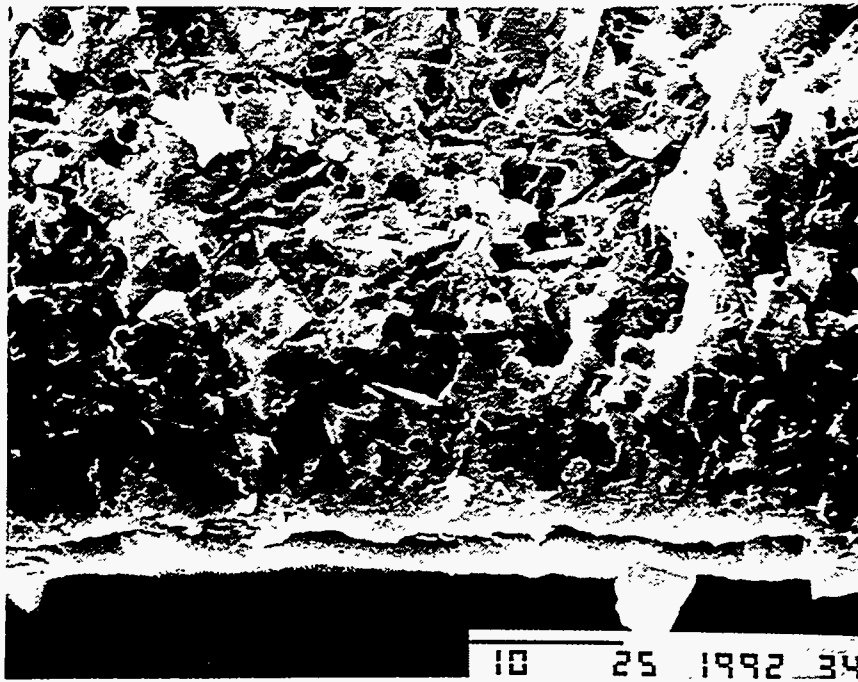
Oxidation Time: 500 hr



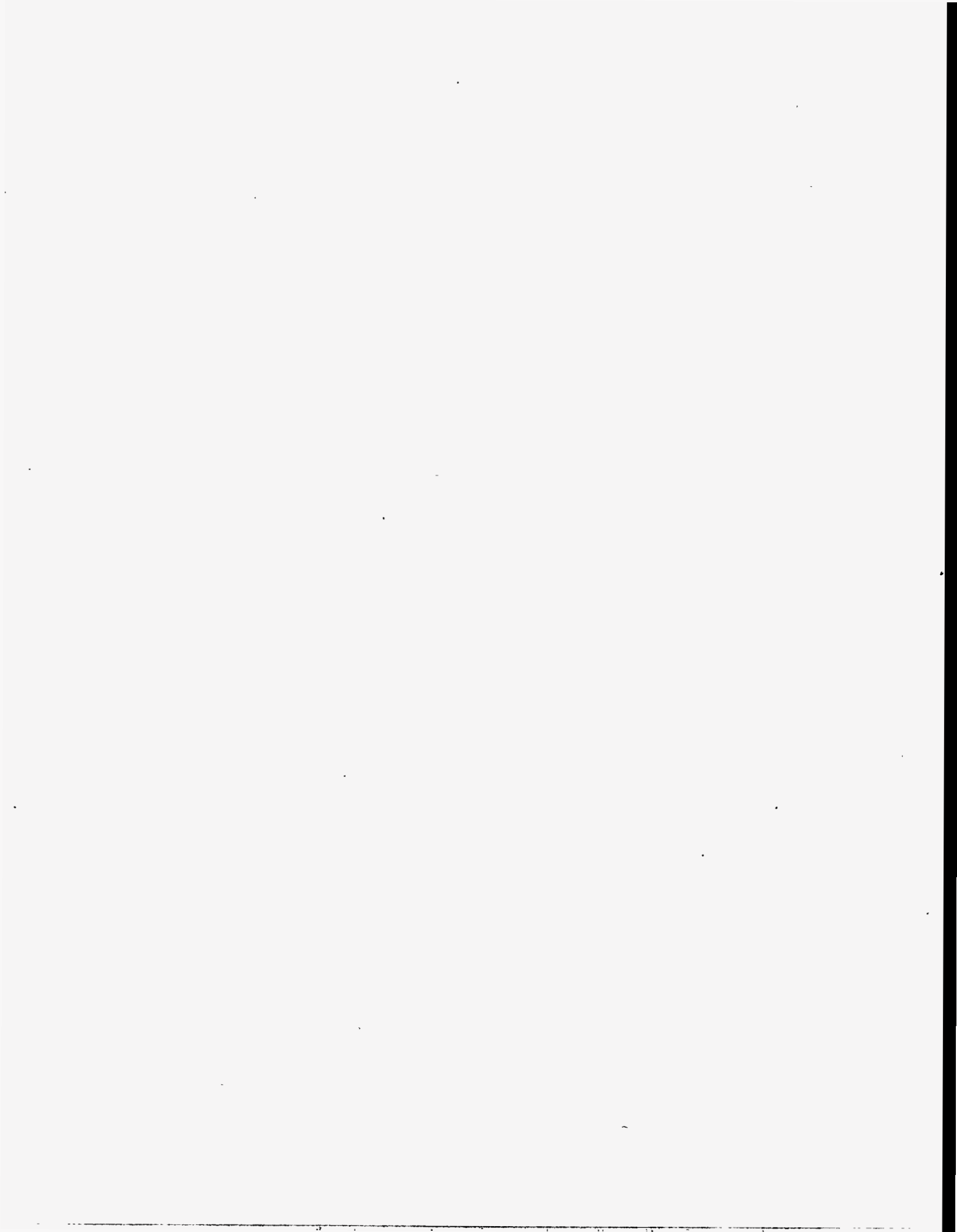


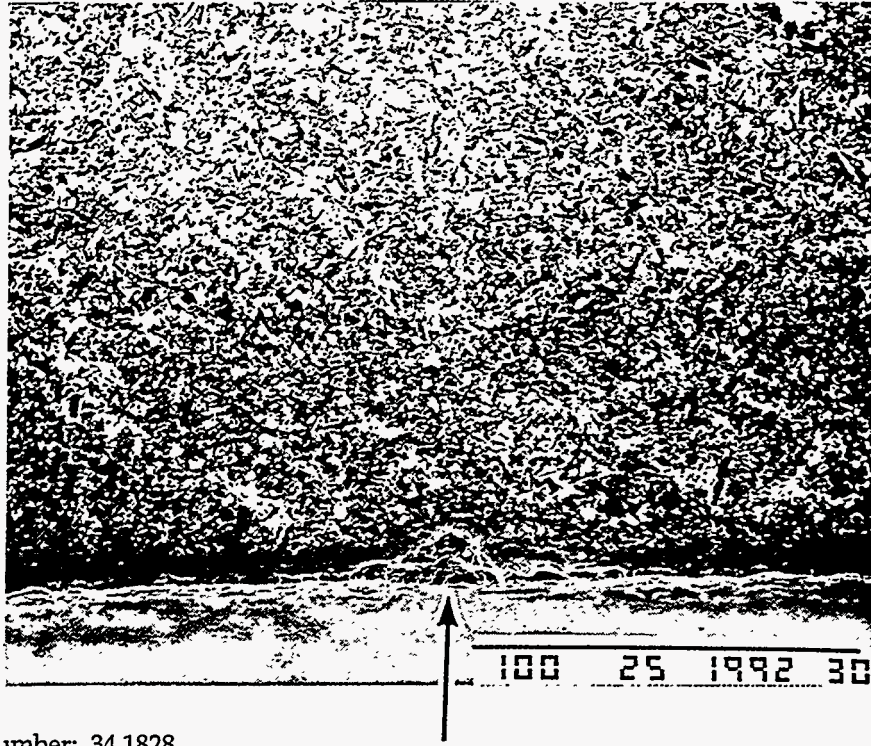
Specimen Number: 34.1823
Oxidation Temperature: 1200°C

Oxidation Time: 500 hr



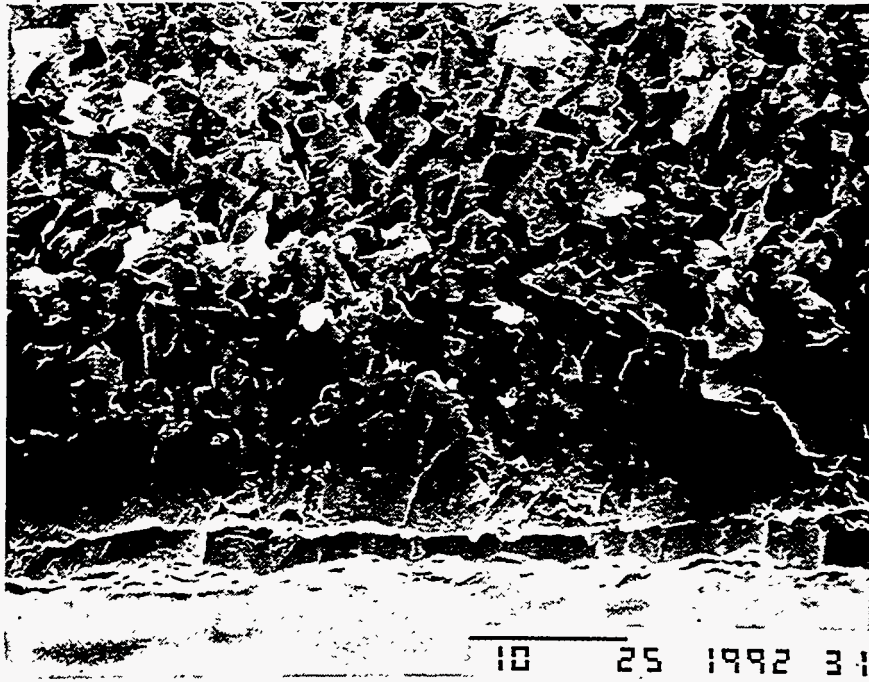
OXIDATION BEHAVIOR OF PY-6 SILICON NITRIDE AT 1260°C IN AIR

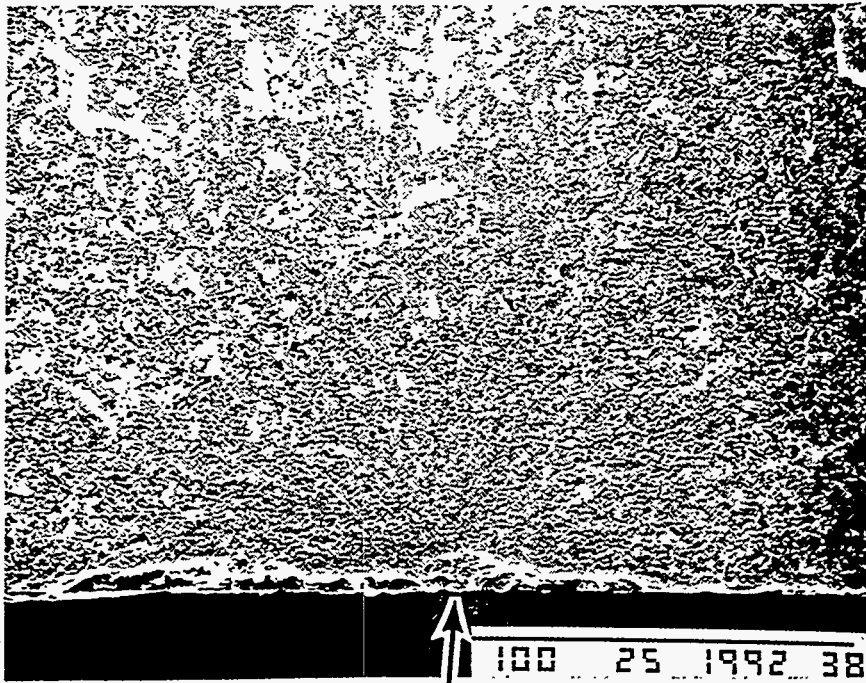




Specimen Number: 34.1828
Oxidation Temperature: 1260°C

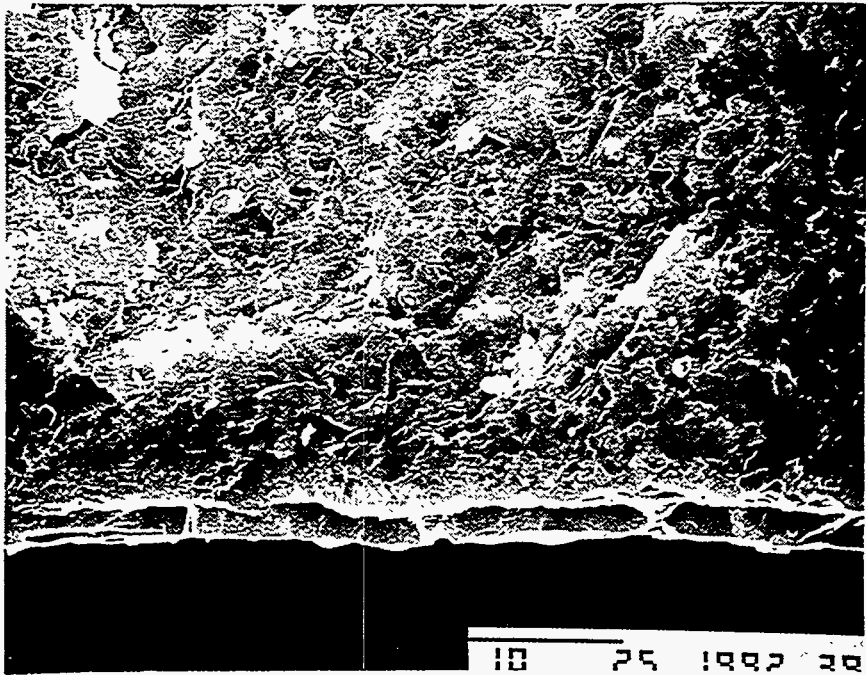
Oxidation Time: 100 hr

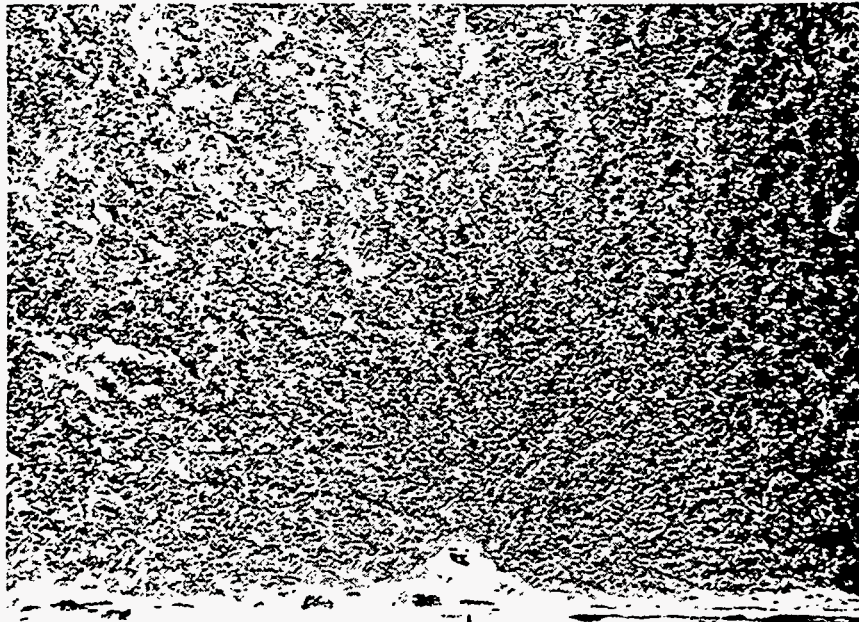




Specimen Number: 34.1826
Oxidation Temperature: 1260°C

Oxidation Time: 100 hr





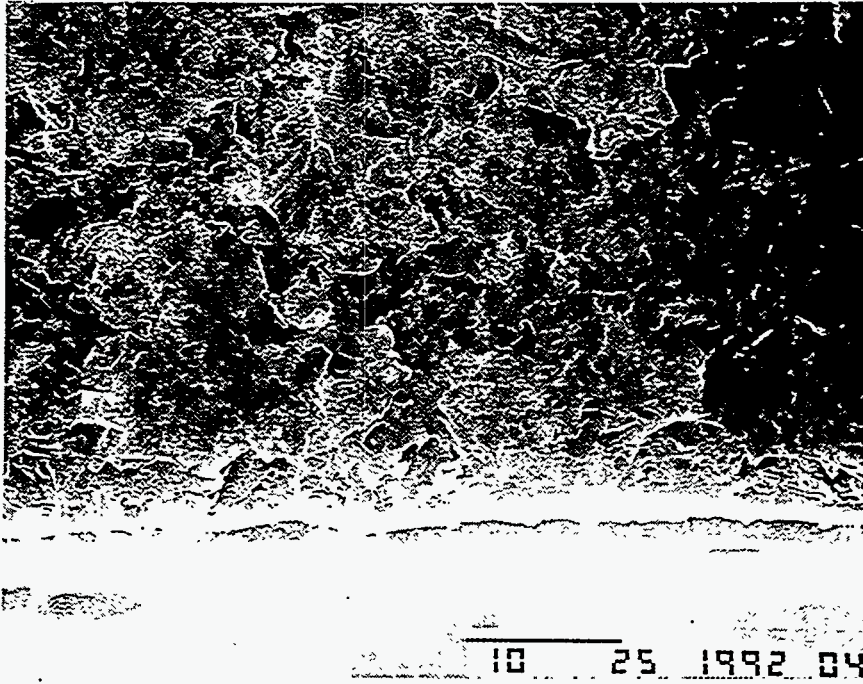
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Specimen Number: 34.1595
Oxidation Temperature: 1260°C

Oxidation Time: 100 hr

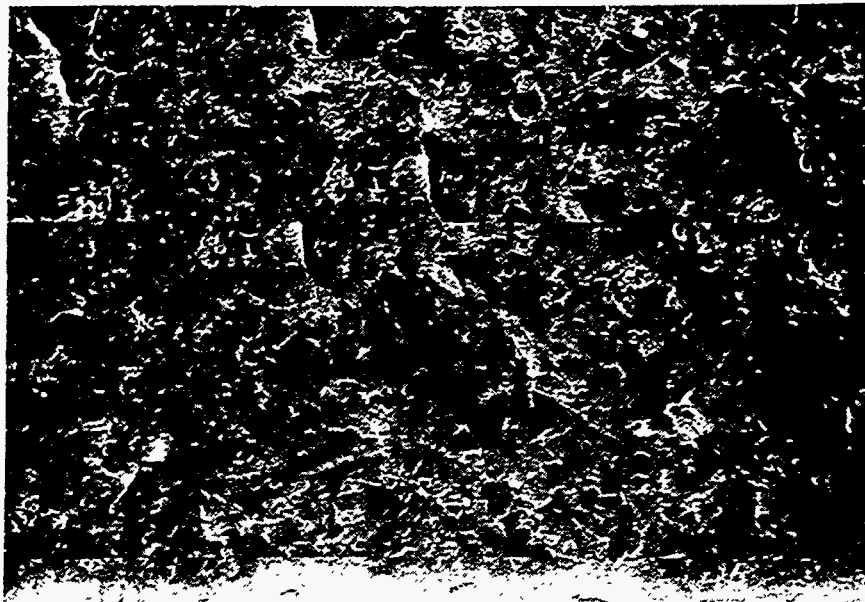


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Specimen Number: 34.1825
Oxidation Temperature: 1260°C

Oxidation Time: 100 hr

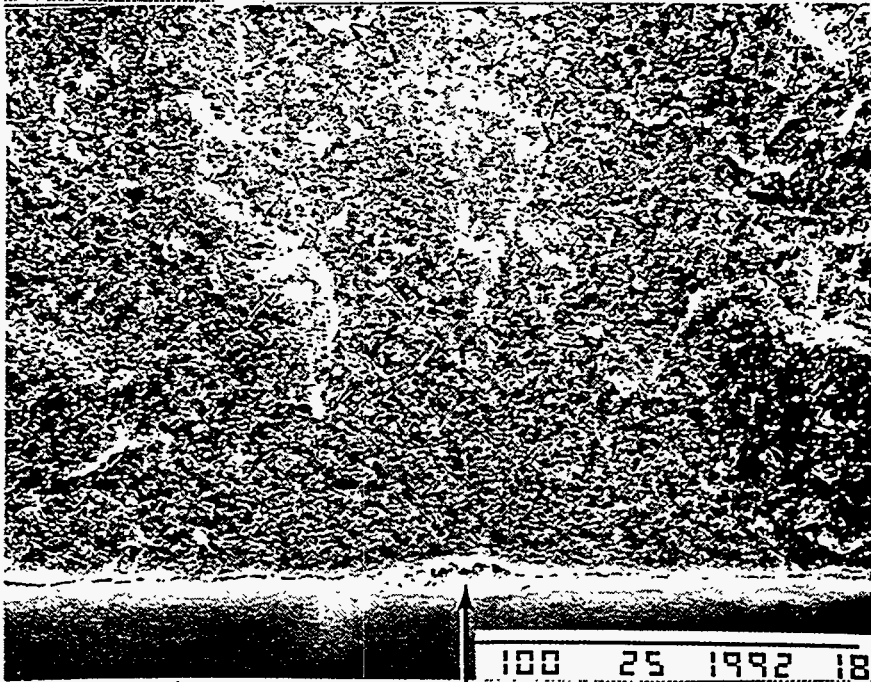


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Specimen Number: 34.2041

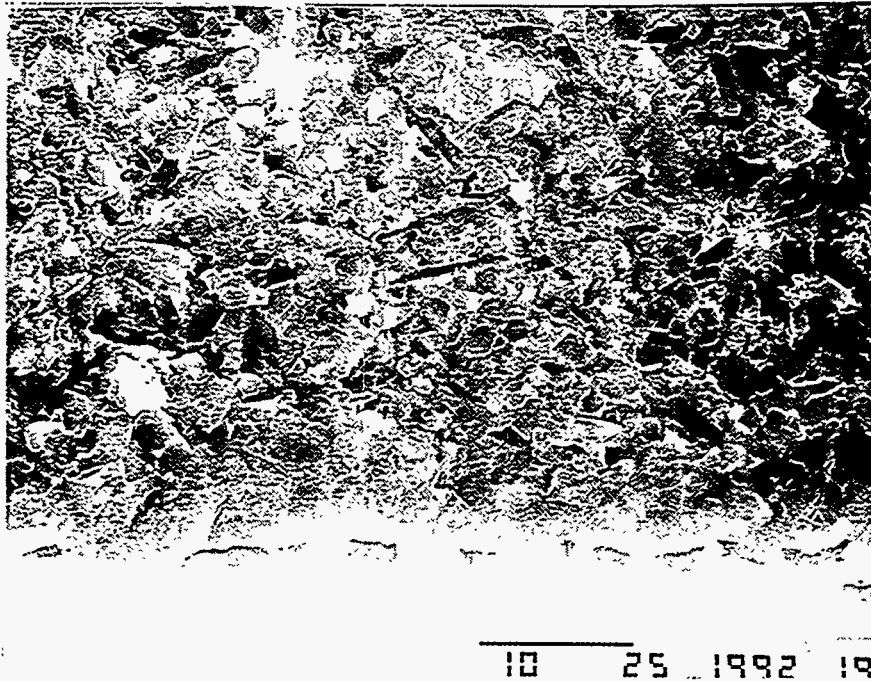
Oxidation Temperature: 1260°C

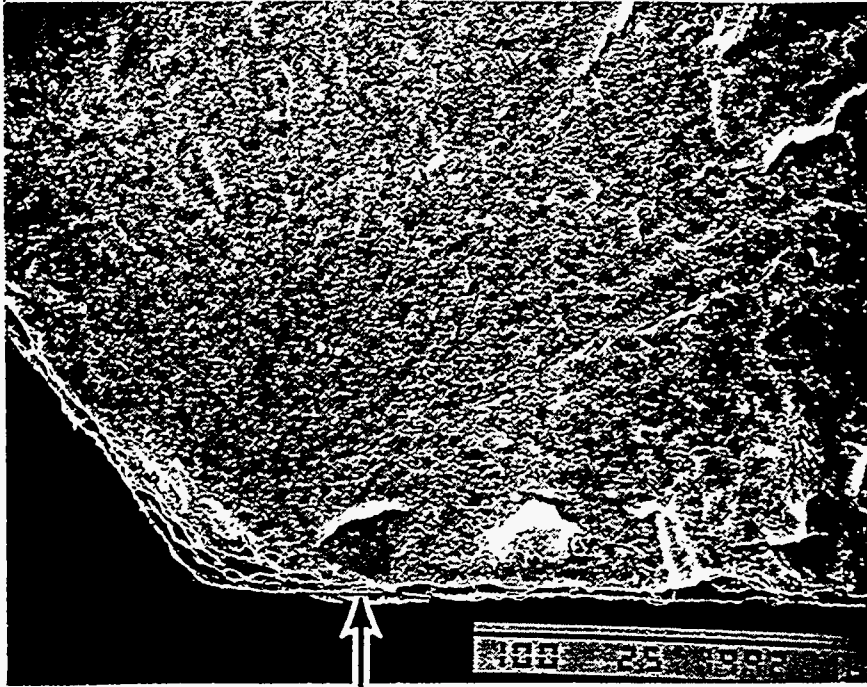
Oxidation Time: 100 hr



Specimen Number: 34.1827
Oxidation Temperature: 1260°C

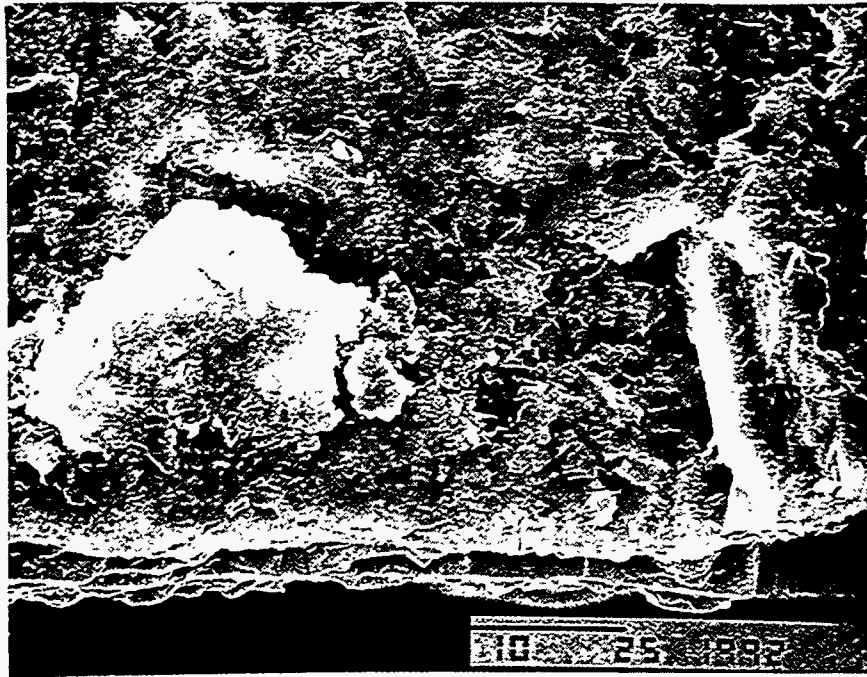
Oxidation Time: 100 hr

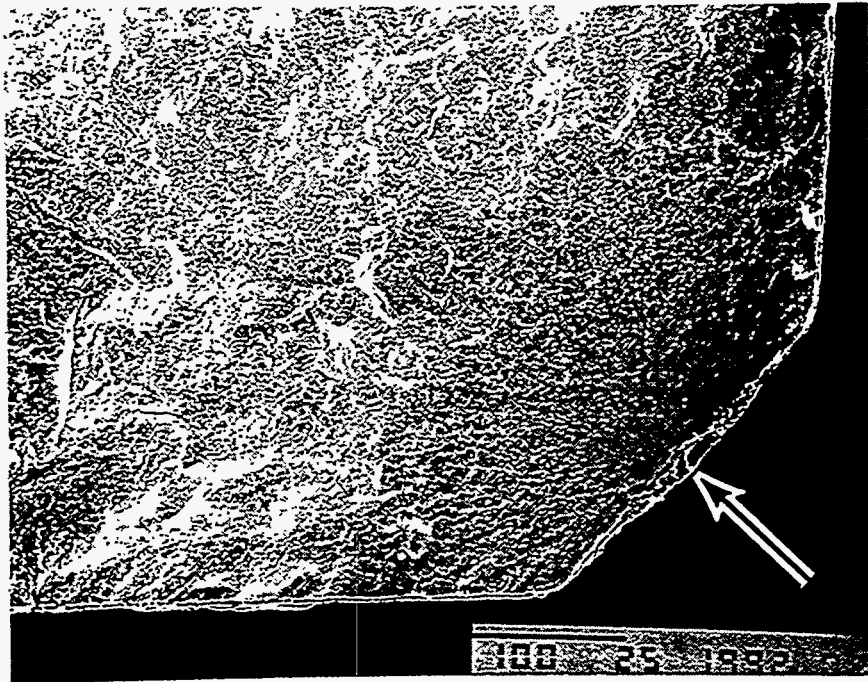




Specimen Number: 34.1576
Oxidation Temperature: 1260°C

Oxidation Time: 100 hr

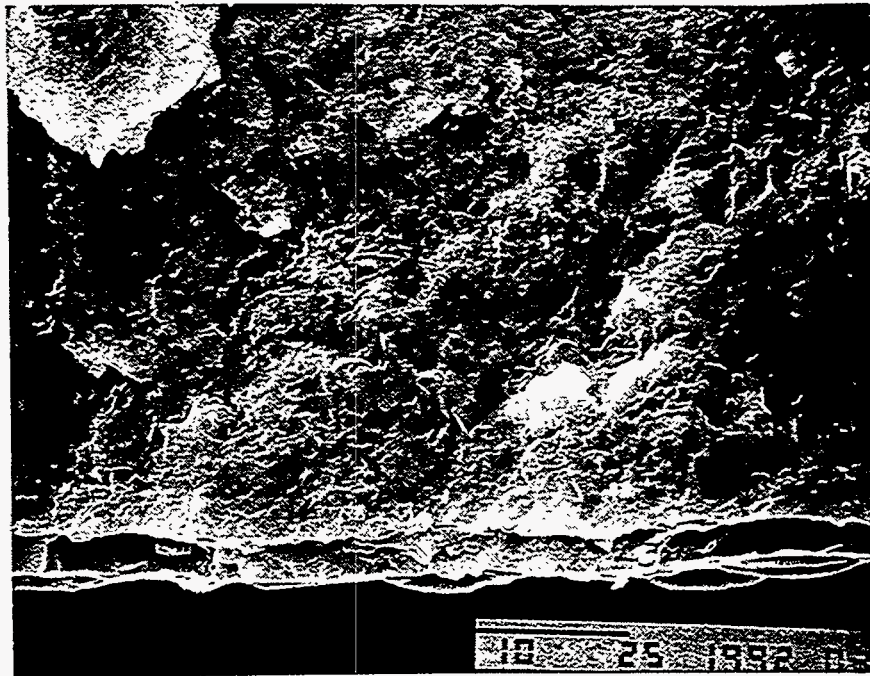


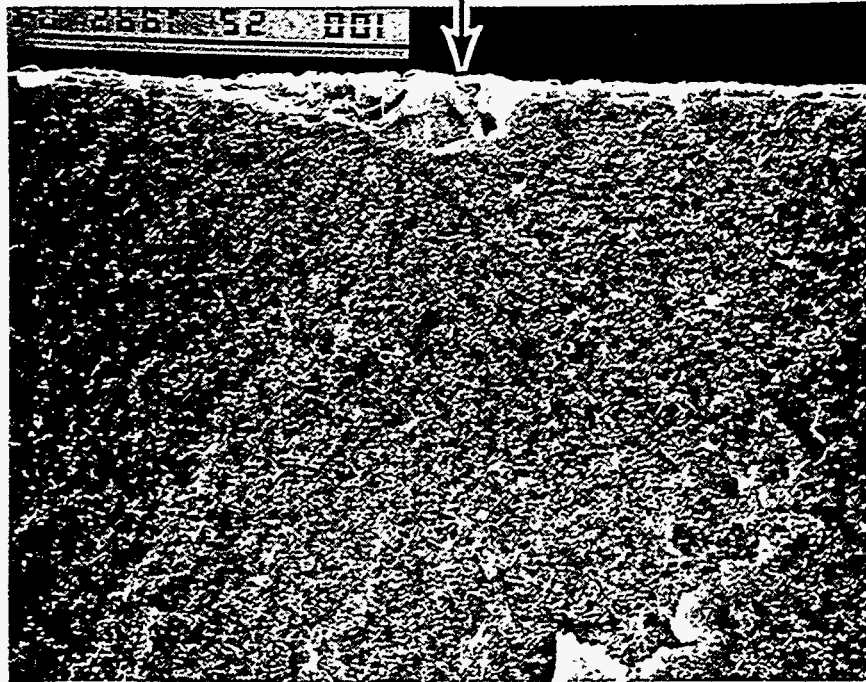
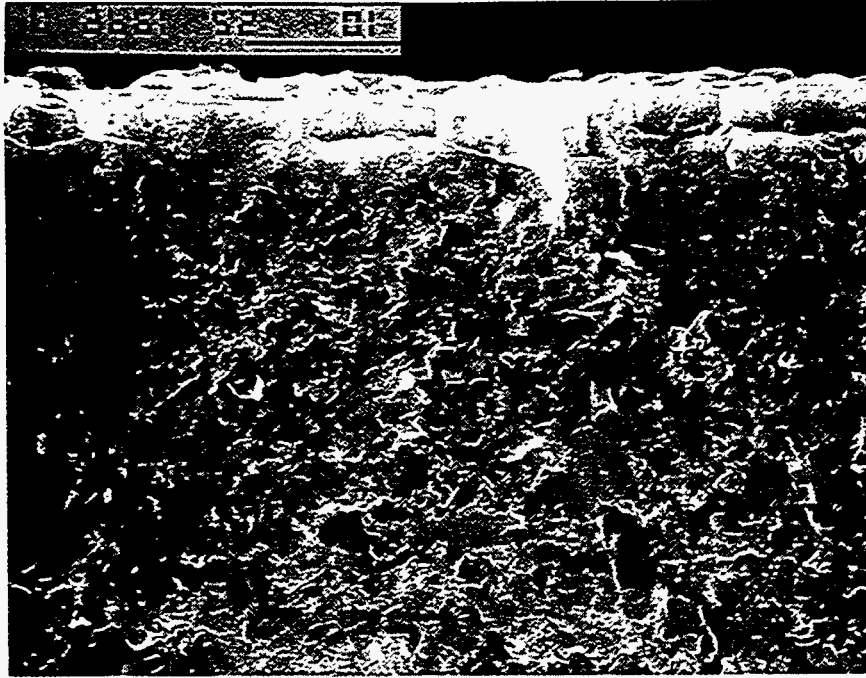


Specimen Number: 34.1577

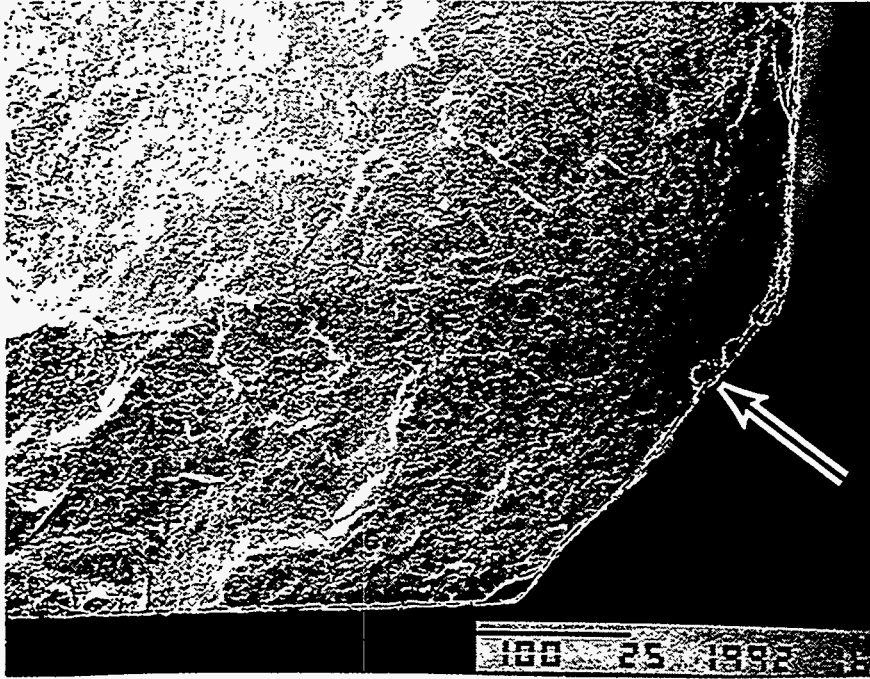
Oxidation Temperature: 1260°C

Oxidation Time: 100 hr



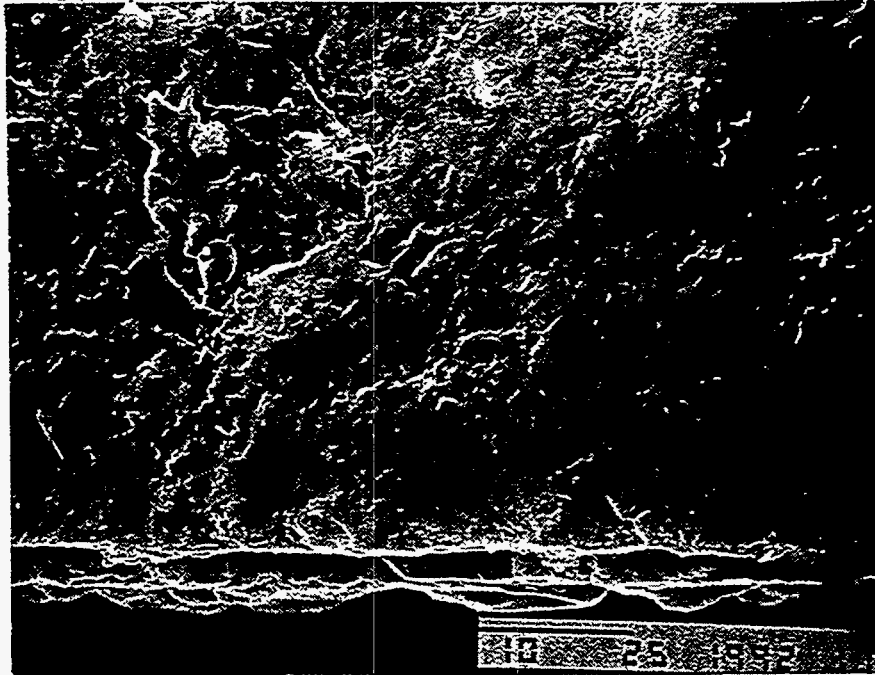


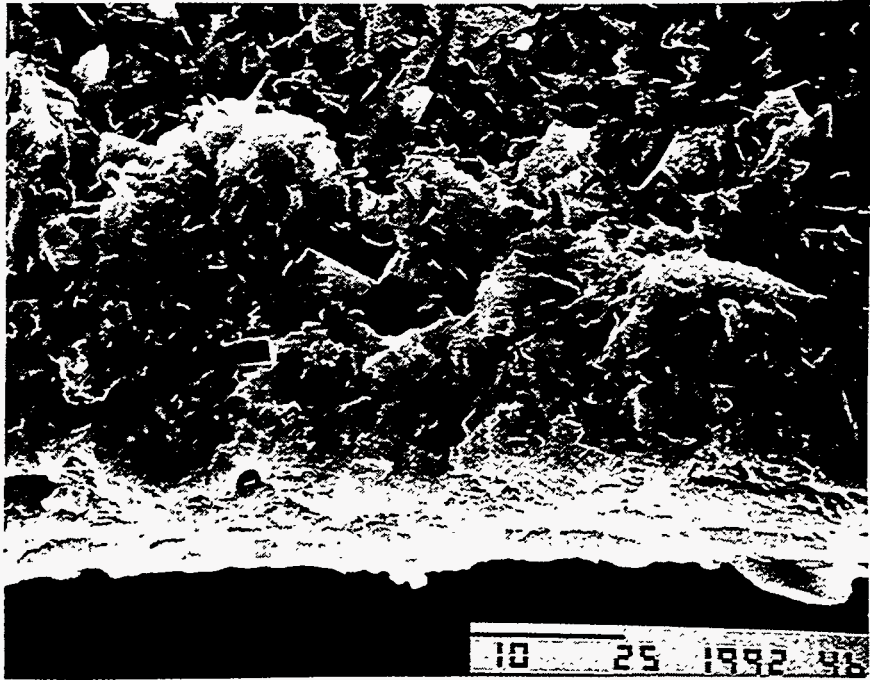
Specimen Number: 34.1578
Oxidation Temperature: 1260°C
Oxidation Time: 100 hr



Specimen Number: 34.1579
Oxidation Temperature: 1260°C

Oxidation Time: 100 hr

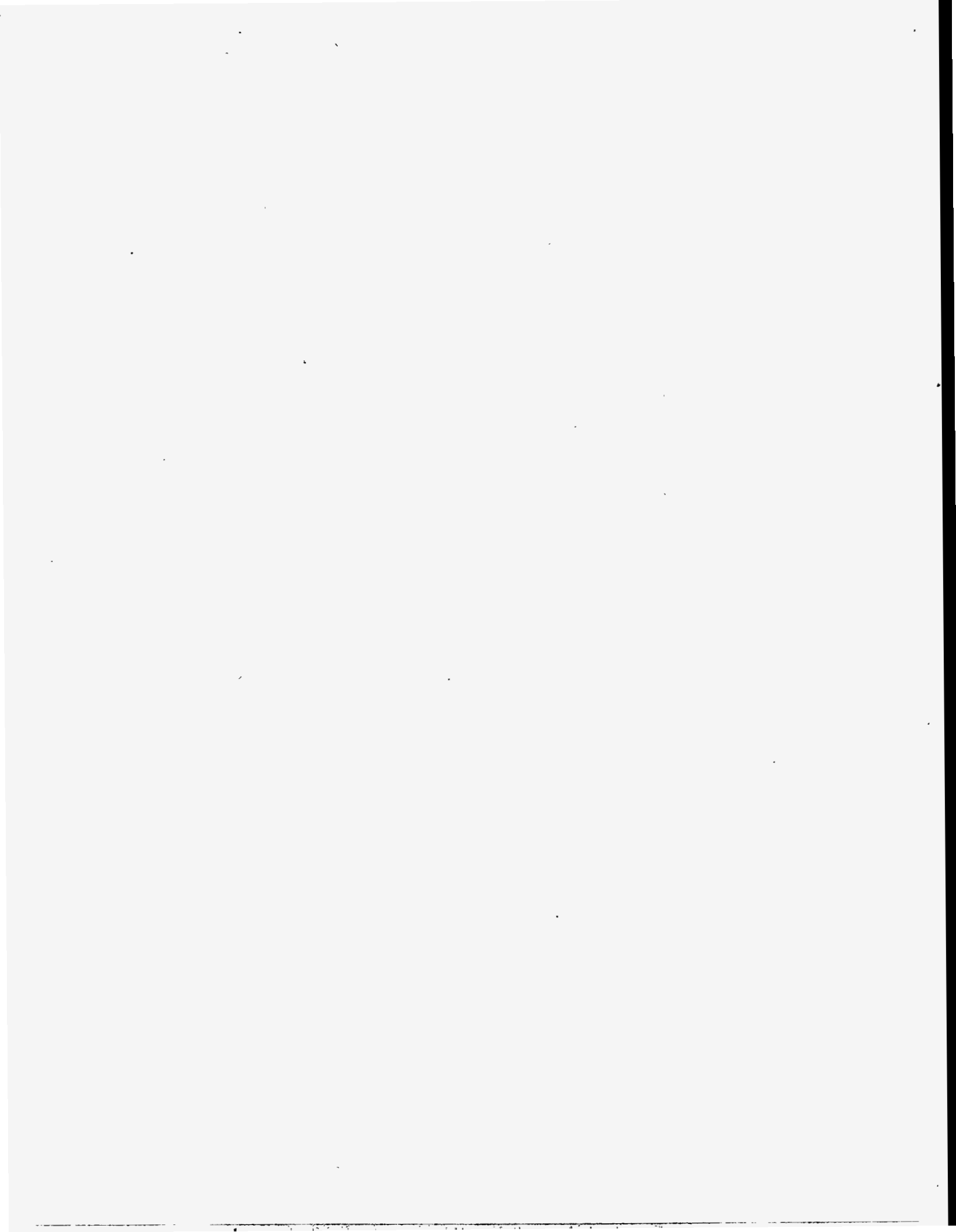




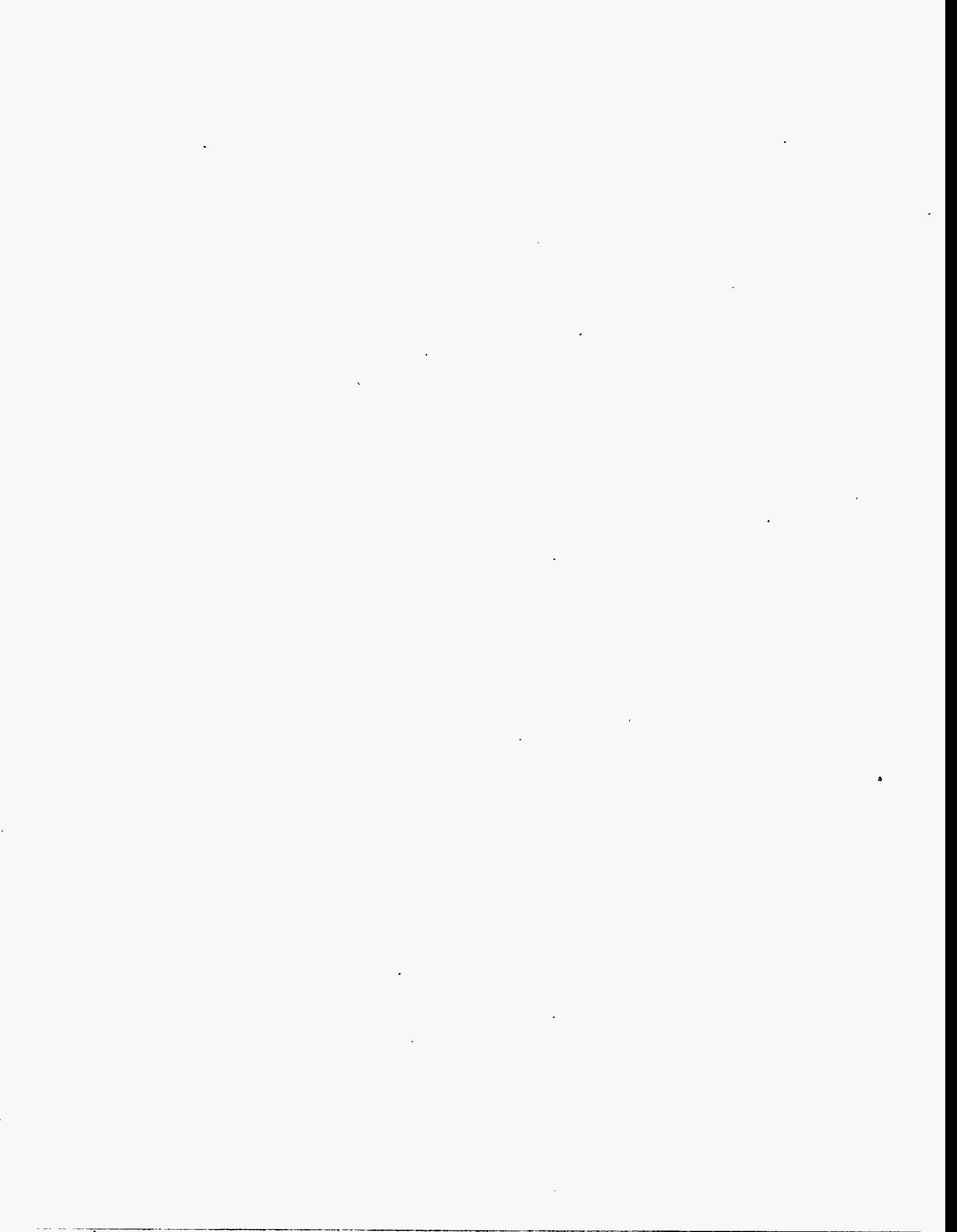
Specimen Number: 34.1843

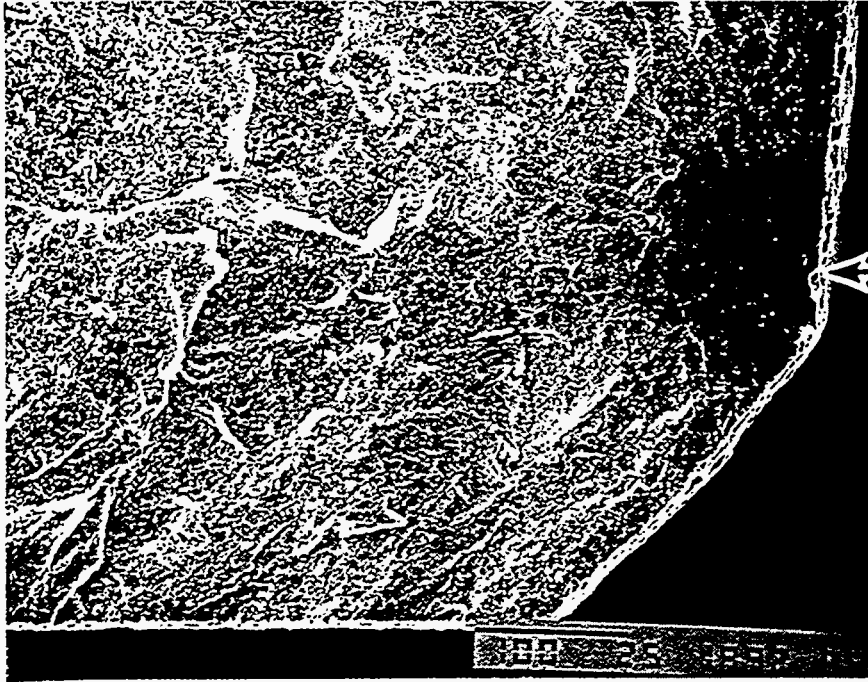
Oxidation Temperature: 1260°C

Oxidation Time: 100 hr



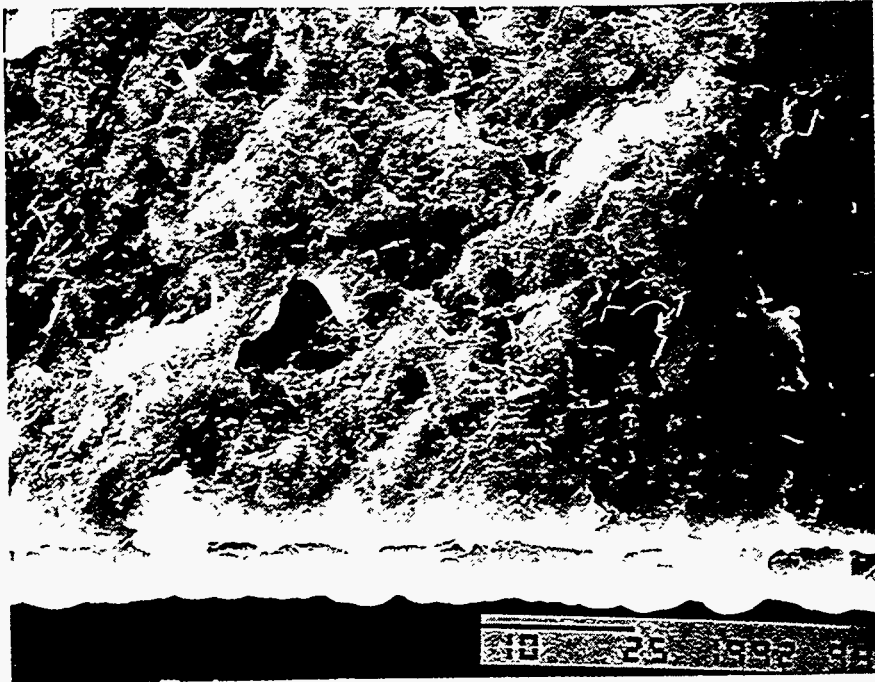
OXIDATION BEHAVIOR OF PY-6 SILICON NITRIDE AT 1300°C IN AIR

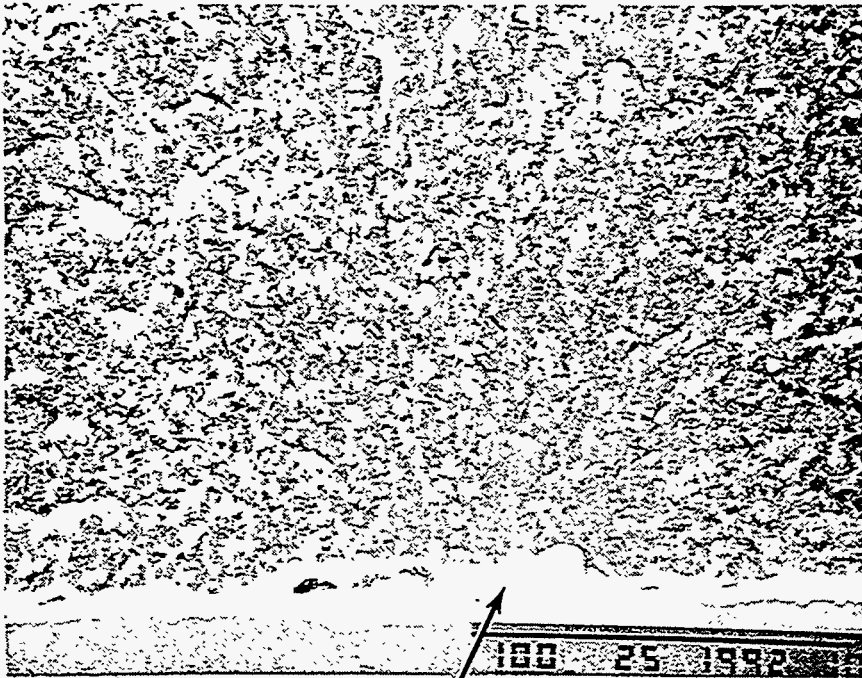




Specimen Number: 34.1477
Oxidation Temperature: 1300°C

Oxidation Time: 100 hr

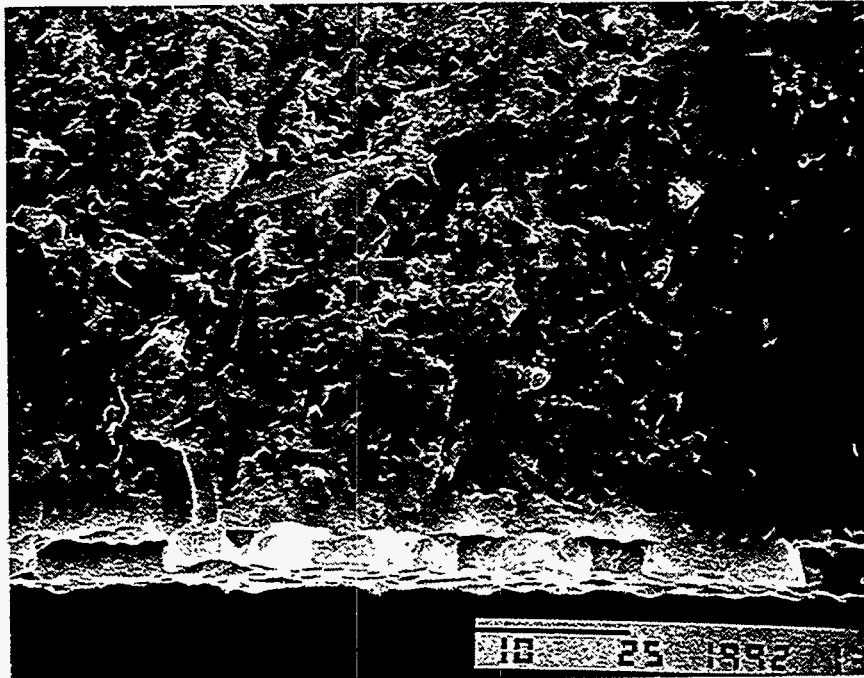


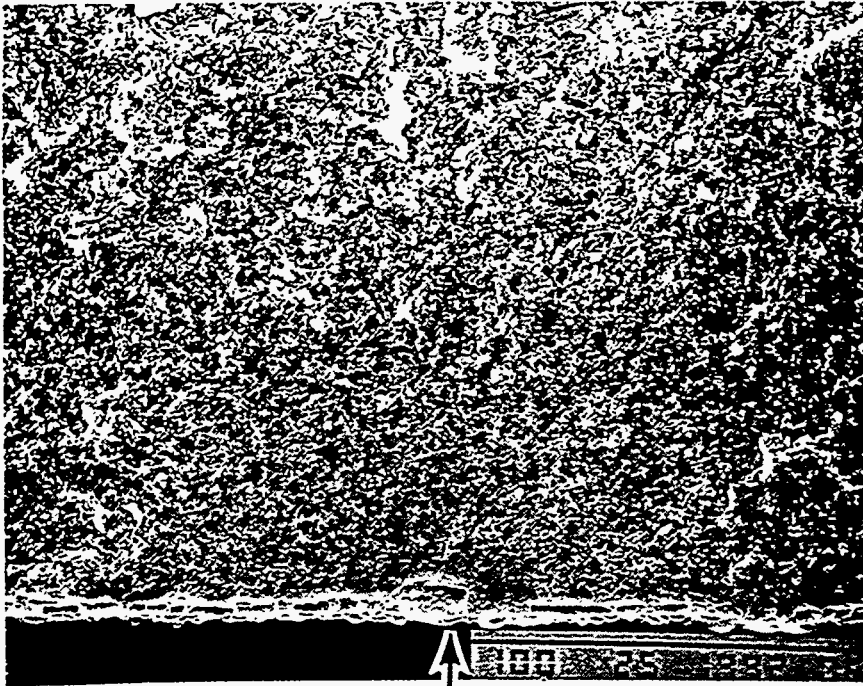


Specimen Number: 34.1478

Oxidation Temperature: 1300°C

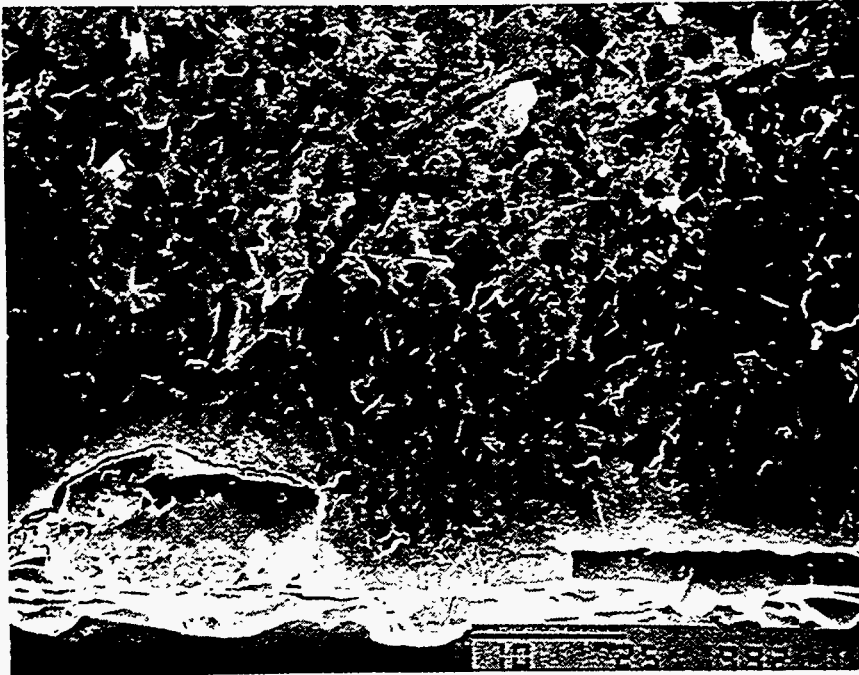
Oxidation Time: 100 hr





Specimen Number: 34.1479
Oxidation Temperature: 1300°C

Oxidation Time: 100 hr

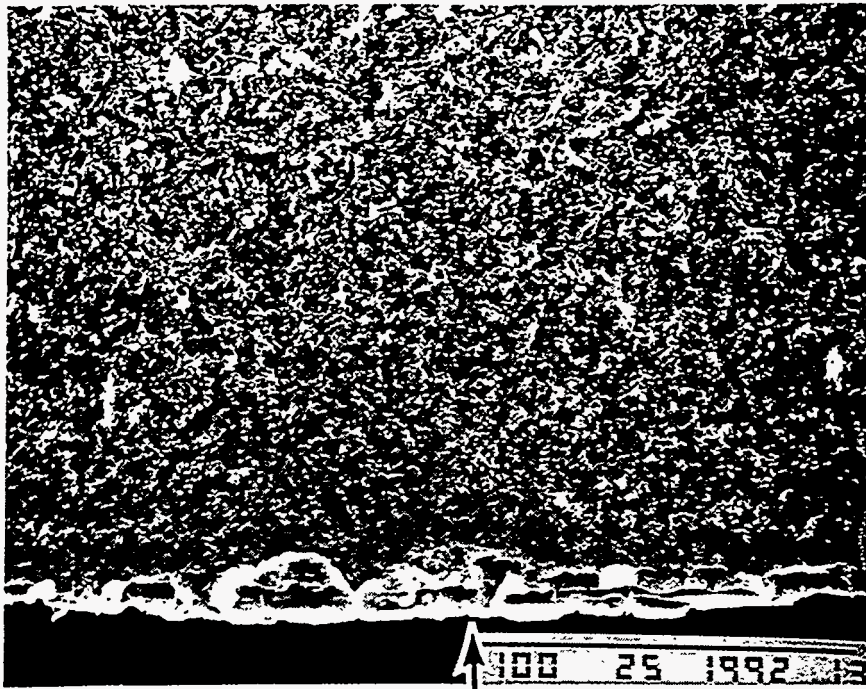




Specimen Number: 34.1525
Oxidation Temperature: 1300°C

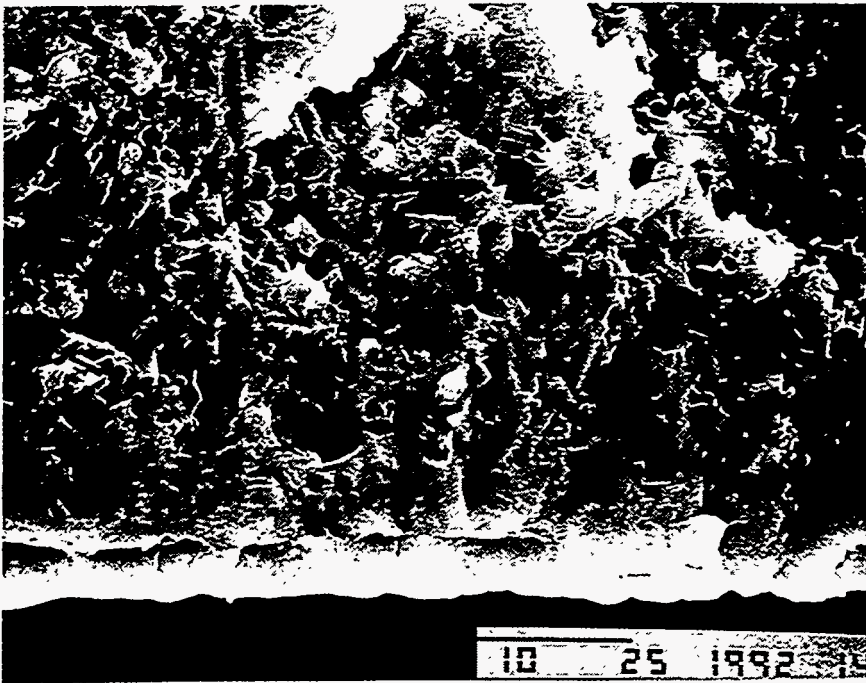
Oxidation Time: 100 hr

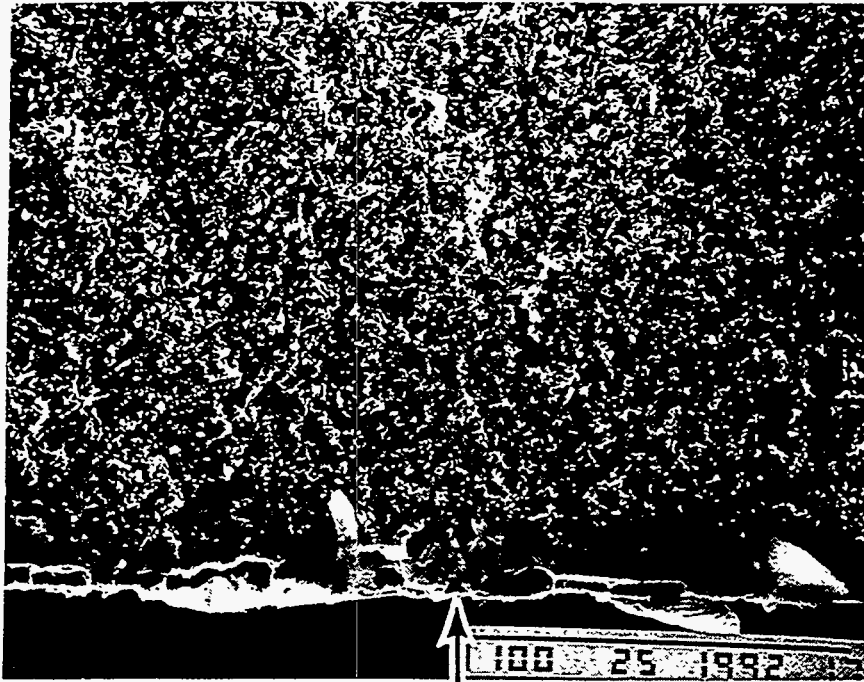




Specimen Number: 34.1845
Oxidation Temperature: 1300°C

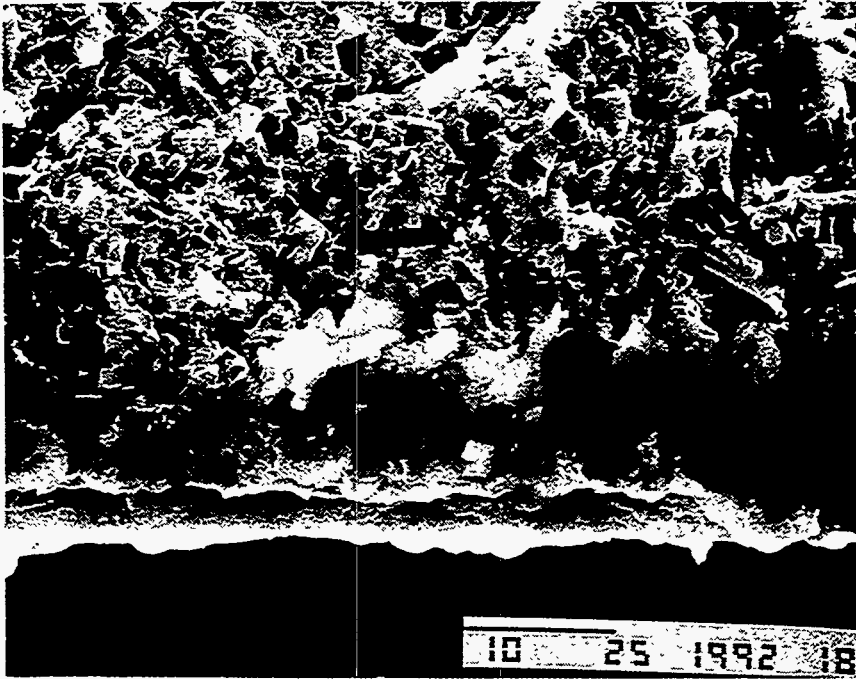
Oxidation Time: 500 hr





Specimen Number: 34.1846
Oxidation Temperature: 1300°C

Oxidation Time: 500 hr



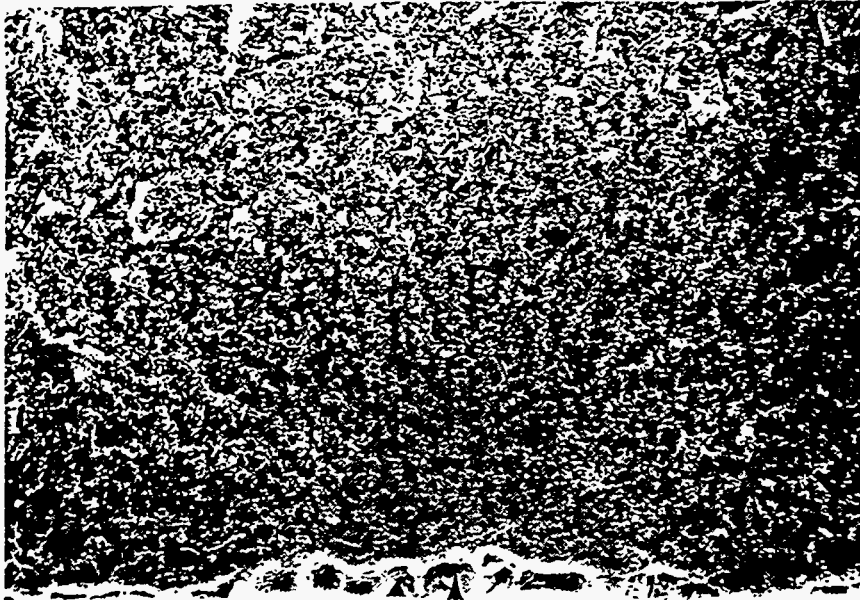


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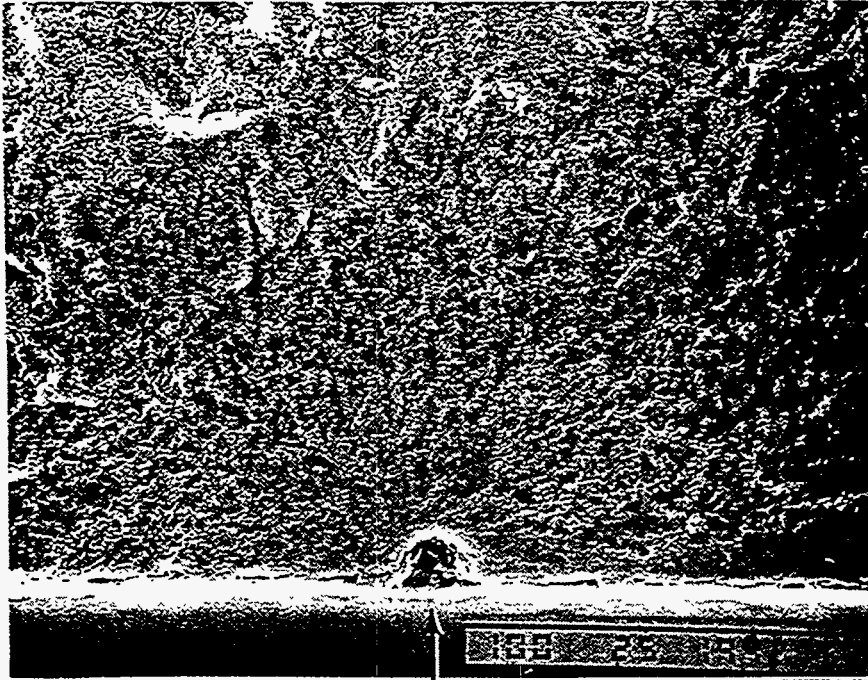
Specimen Number: 34.1847

Oxidation Temperature: 1300°C

Oxidation Time: 500 hr

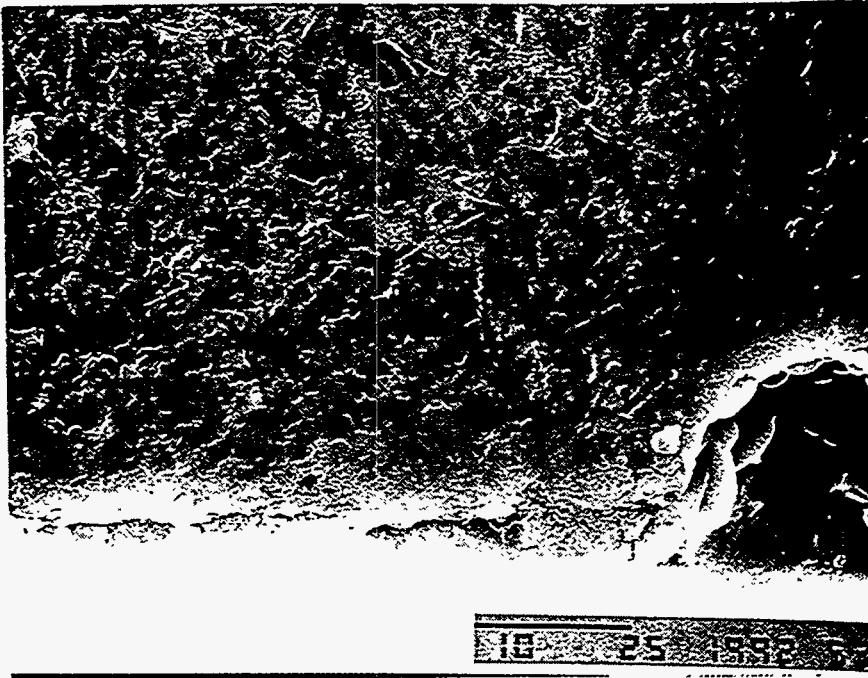


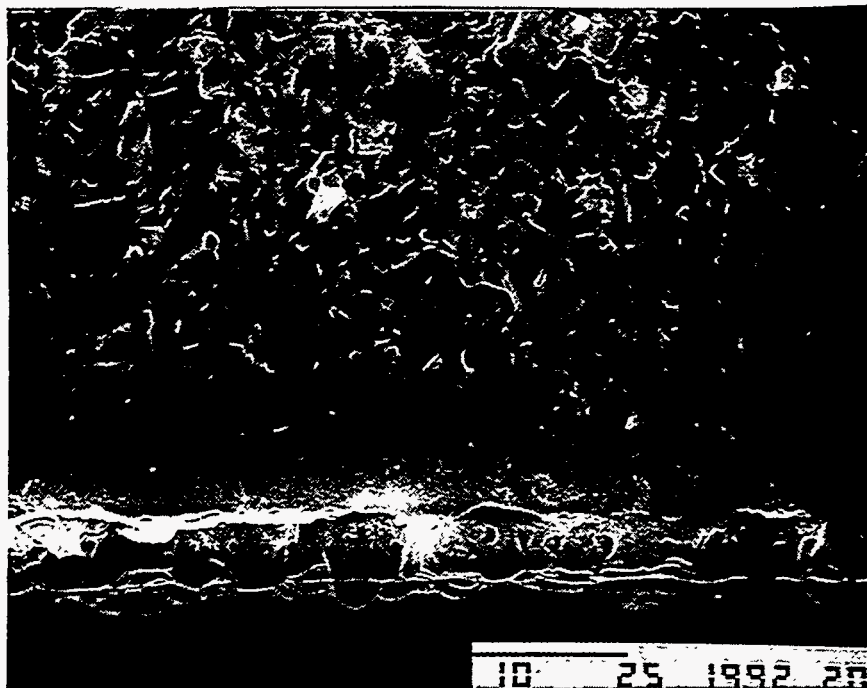
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Specimen Number: 34.1846
Oxidation Temperature: 1300°C

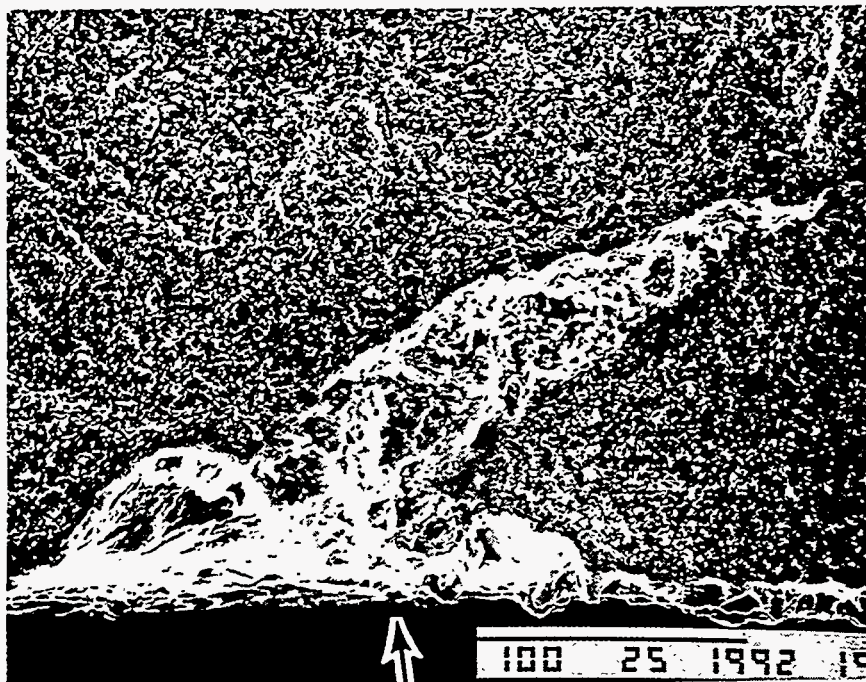
Oxidation Time: 500 hr



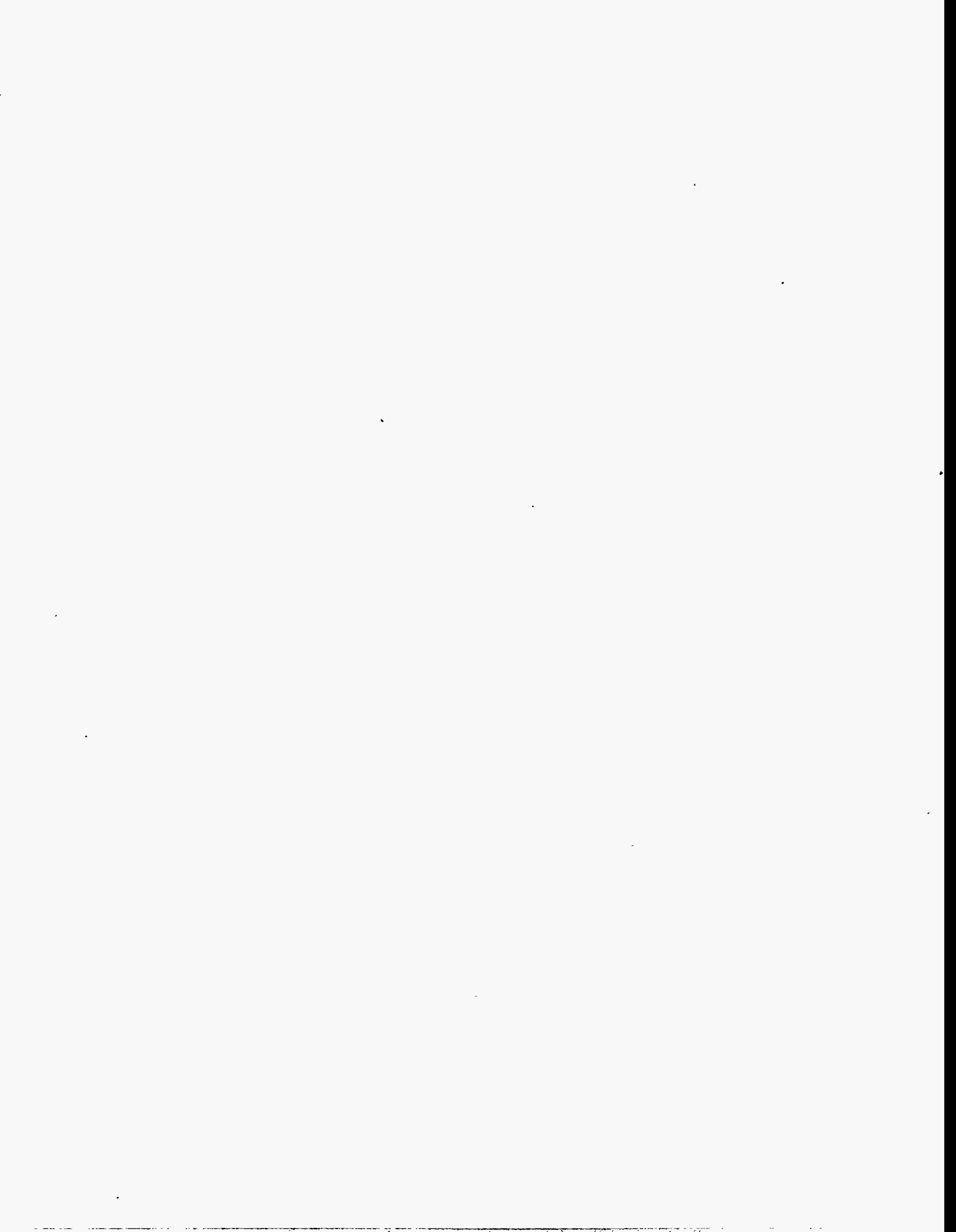


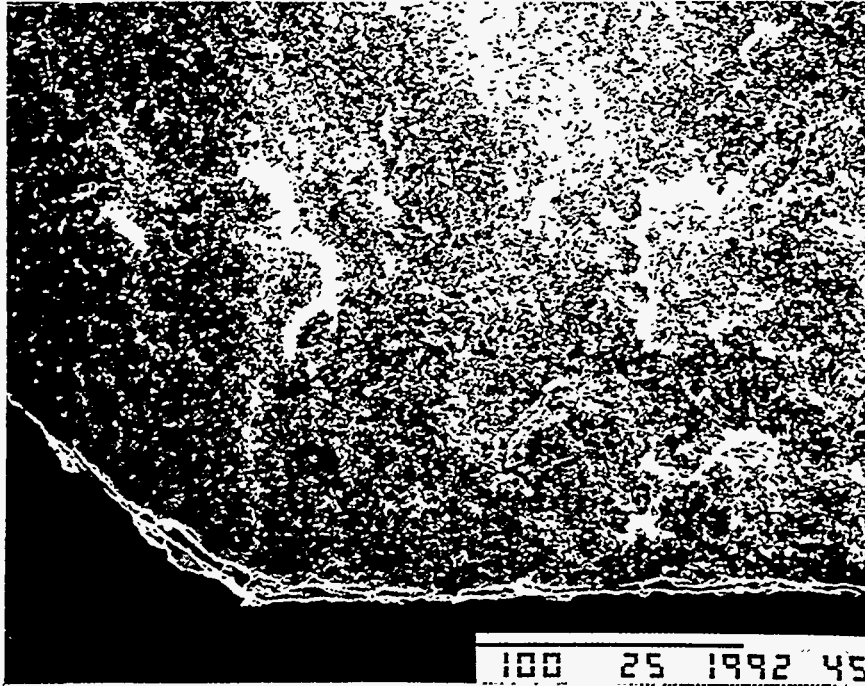
Specimen Number: 34.1849
Oxidation Temperature: 1300°C

Oxidation Time: 500 hr



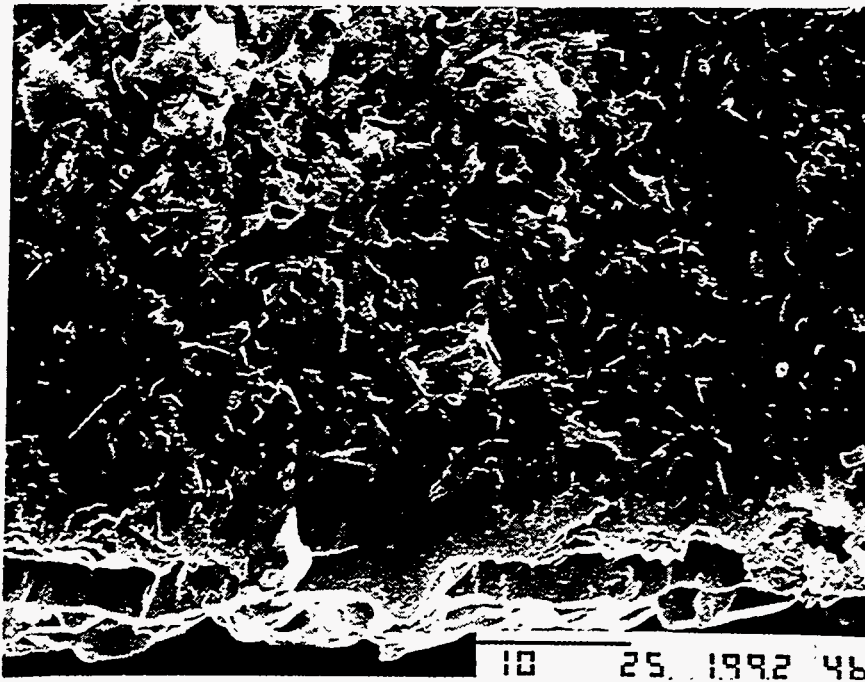
OXIDATION BEHAVIOR OF PY-6 SILICON NITRIDE AT 1371°C IN AIR

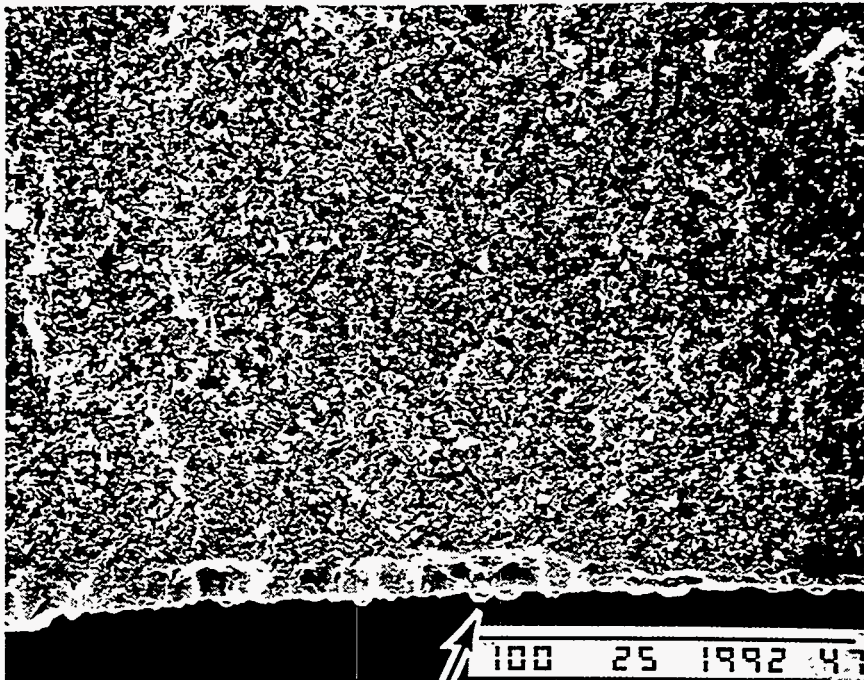




Specimen Number: 34.2070
Oxidation Temperature: 1371°C

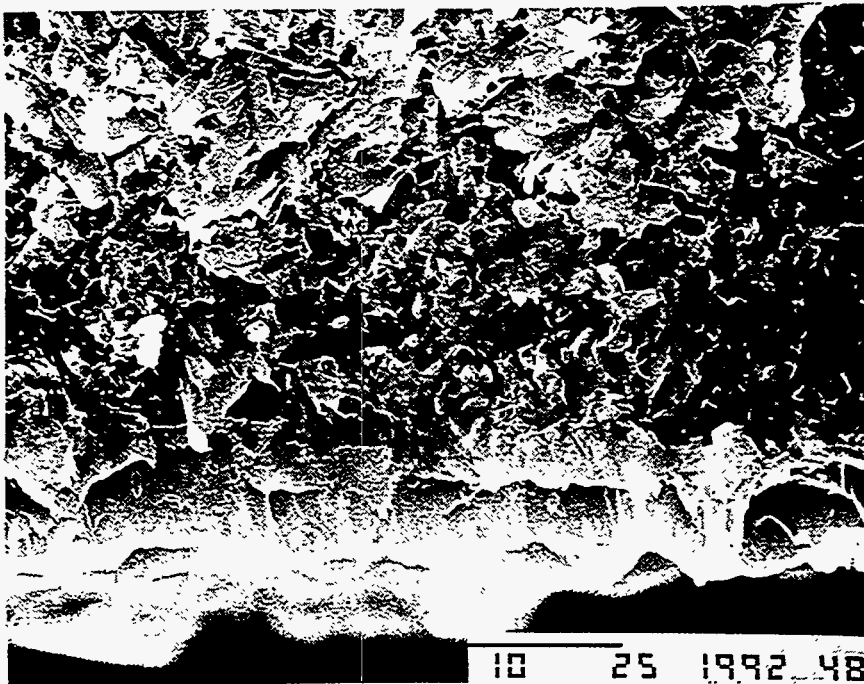
Oxidation Time: 100 hr

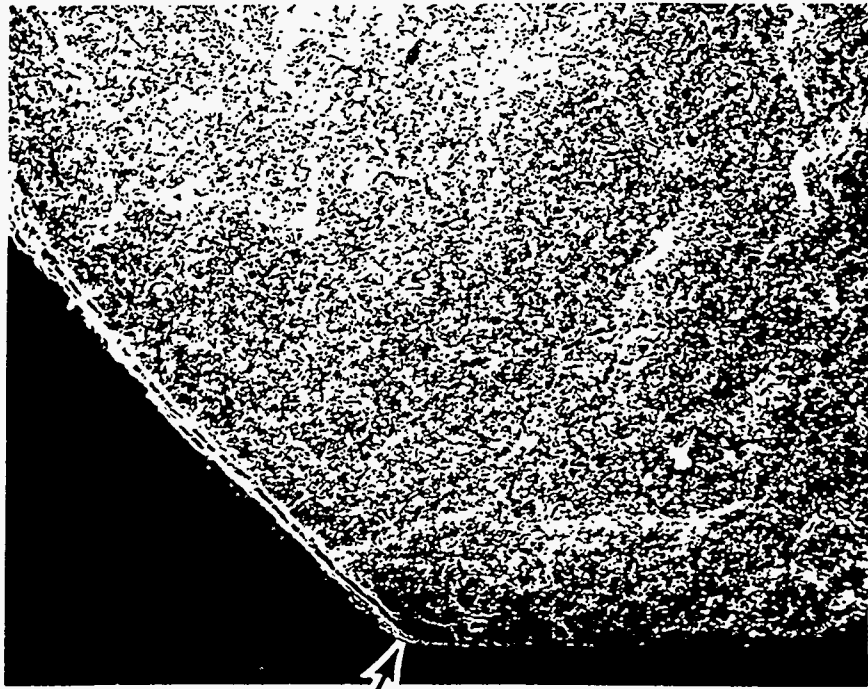




Specimen Number: 34.2067
Oxidation Temperature: 1371°C

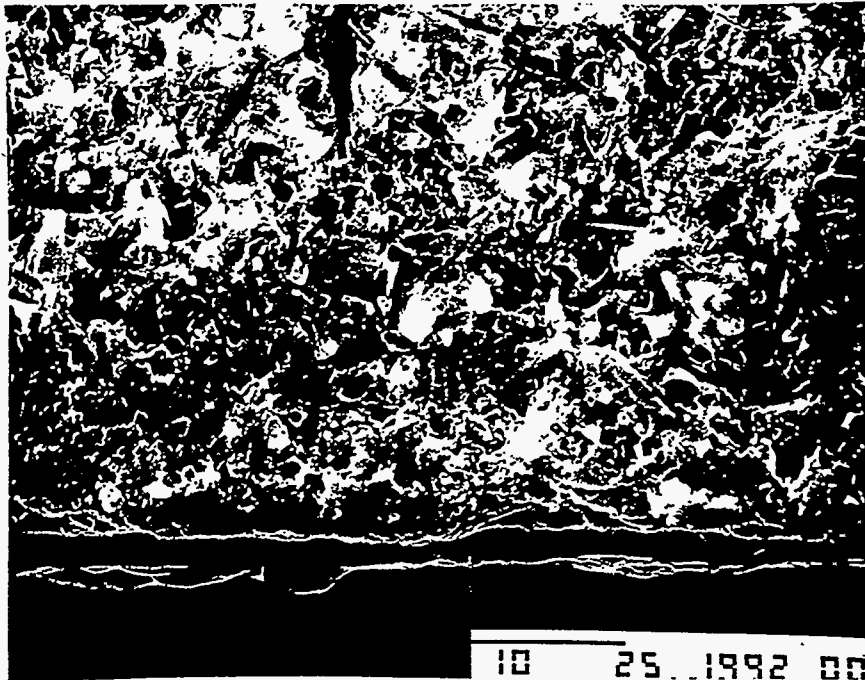
Oxidation Time: 100 hr



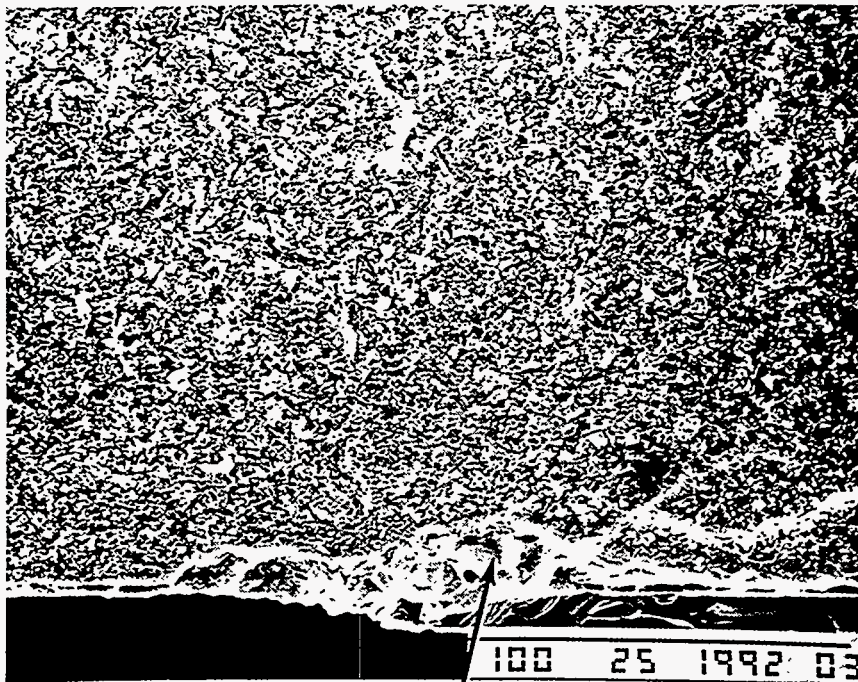


Specimen Number: 34.2069
Oxidation Temperature: 1371°C

Oxidation Time: 100 hr

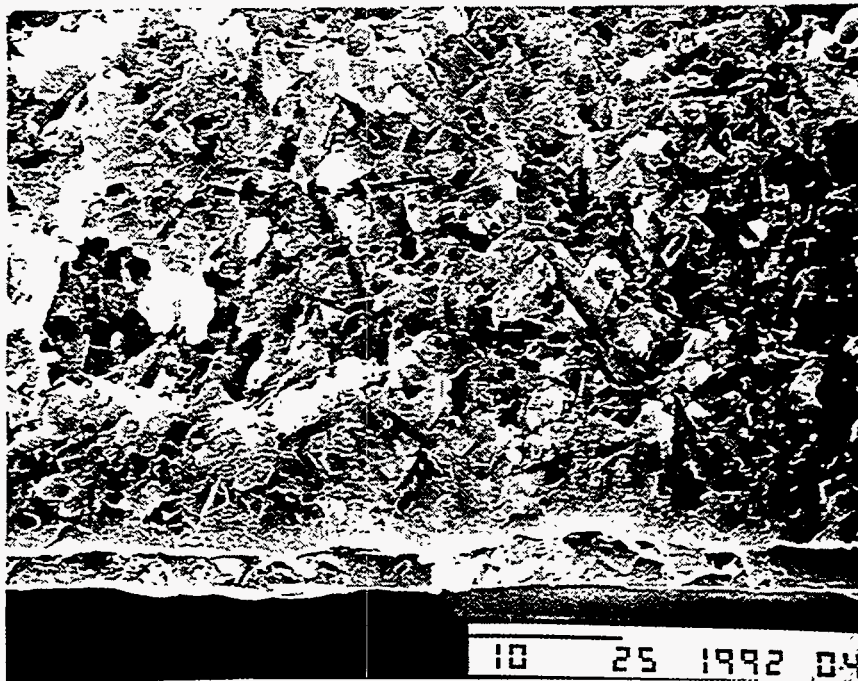


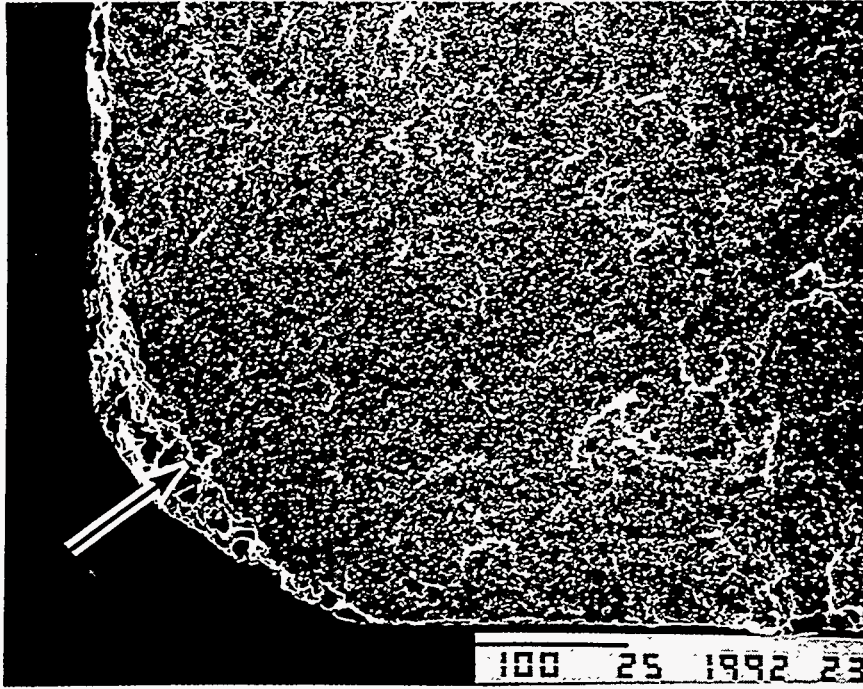
10 25.1992 00



Specimen Number: 34.2068
Oxidation Temperature: 1371°C

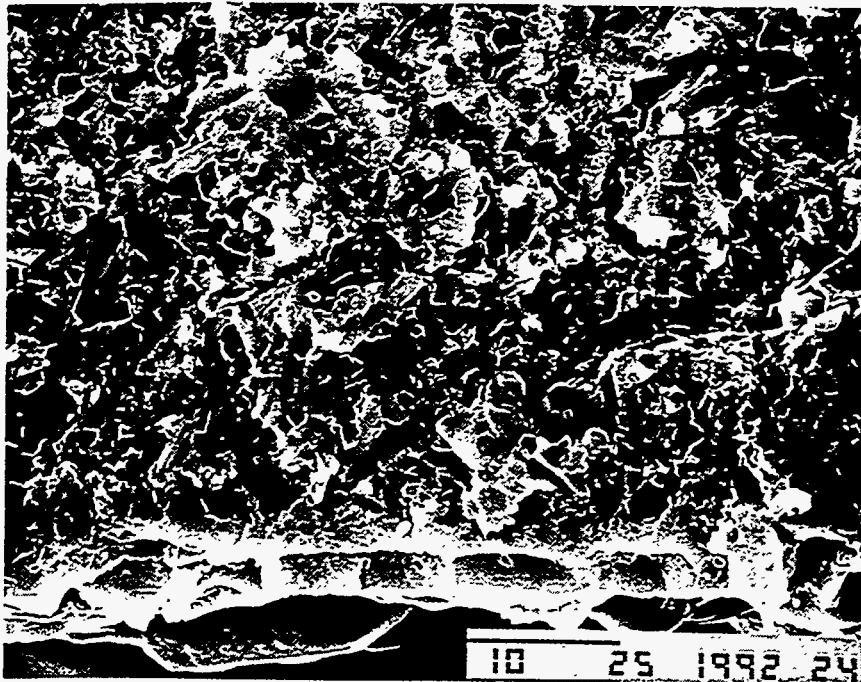
Oxidation Time: 100 hr

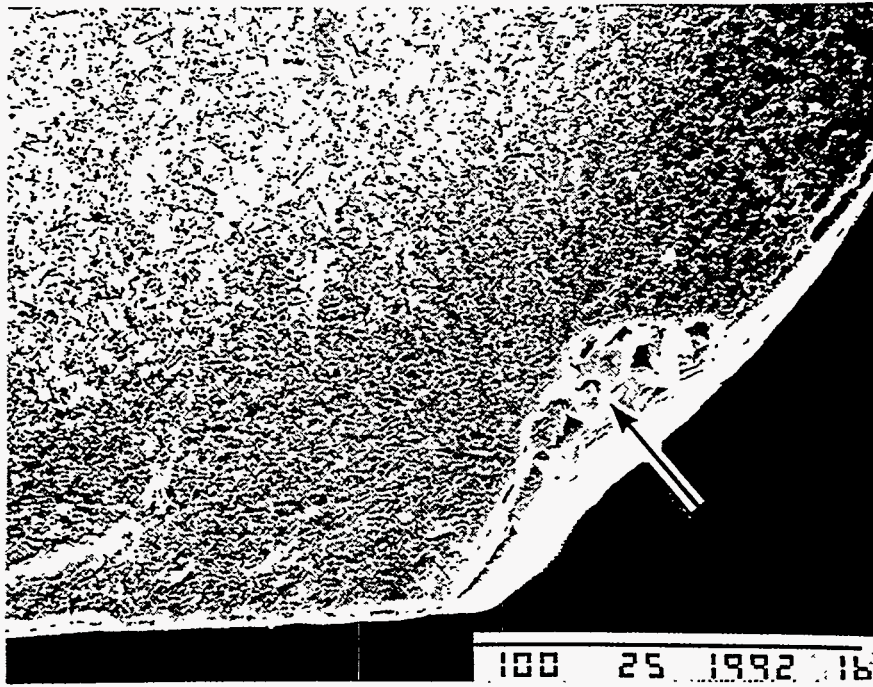




Specimen Number: 34.2066
Oxidation Temperature: 1371°C

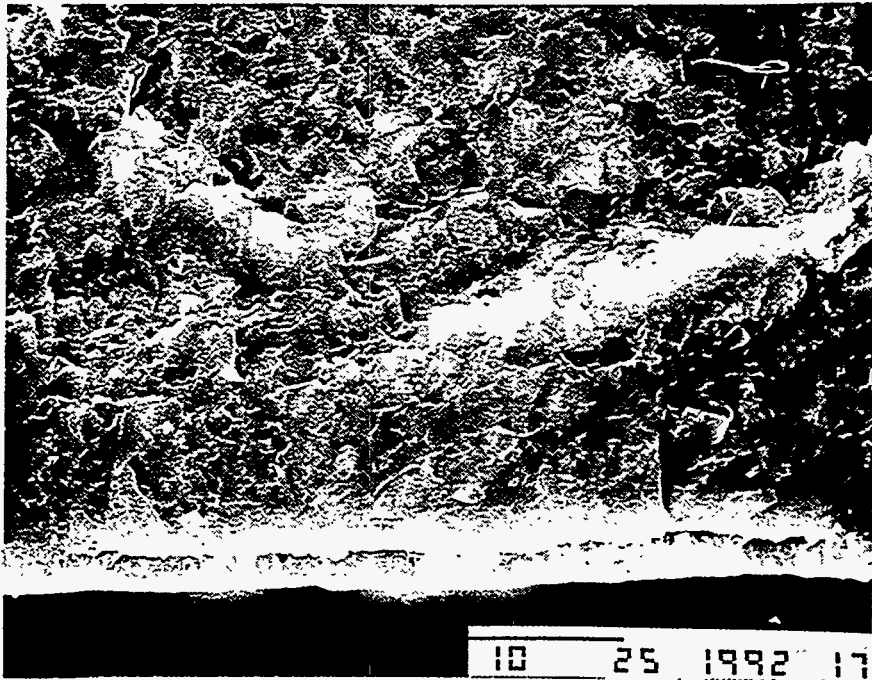
Oxidation Time: 100 hr

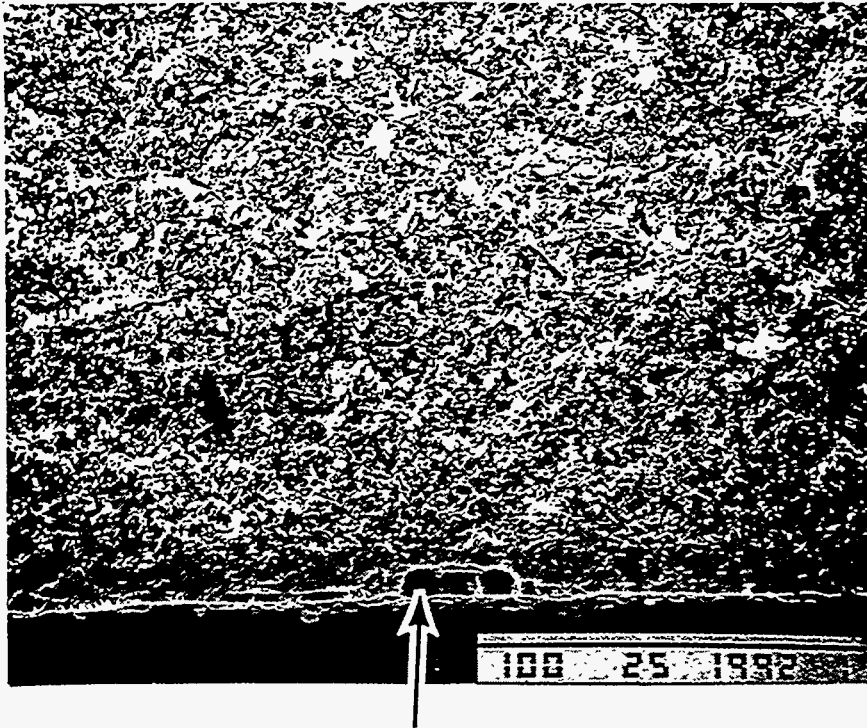




Specimen Number: 34.1575
Oxidation Temperature: 1371°C

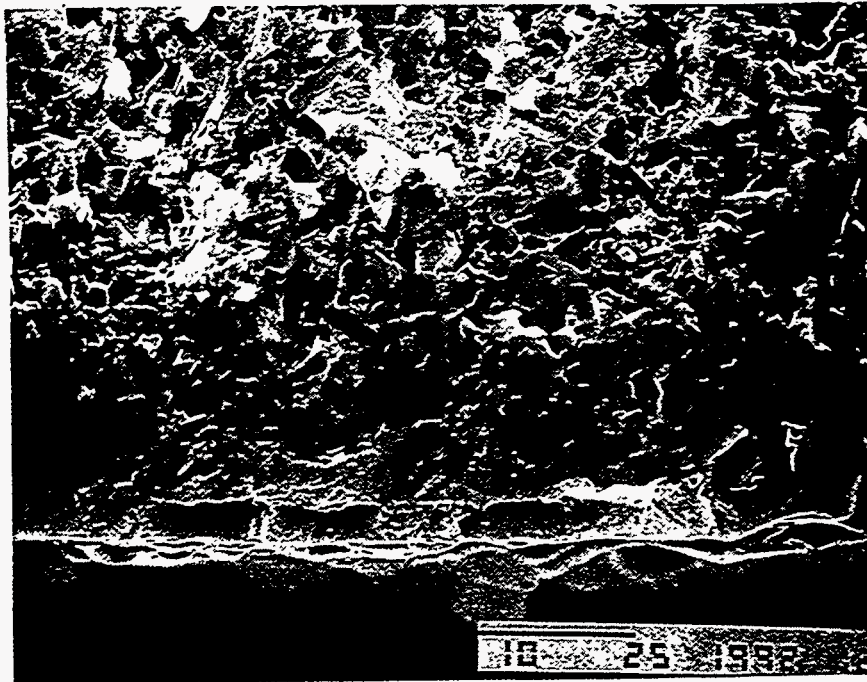
Oxidation Time: 100 hr

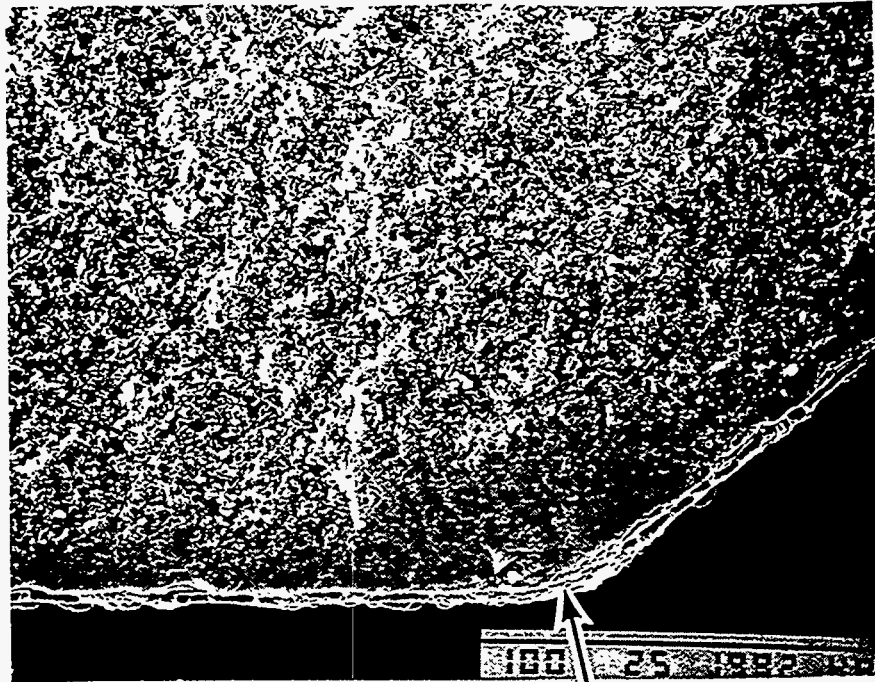




Specimen Number: 34.1751
Oxidation Temperature: 1371°C

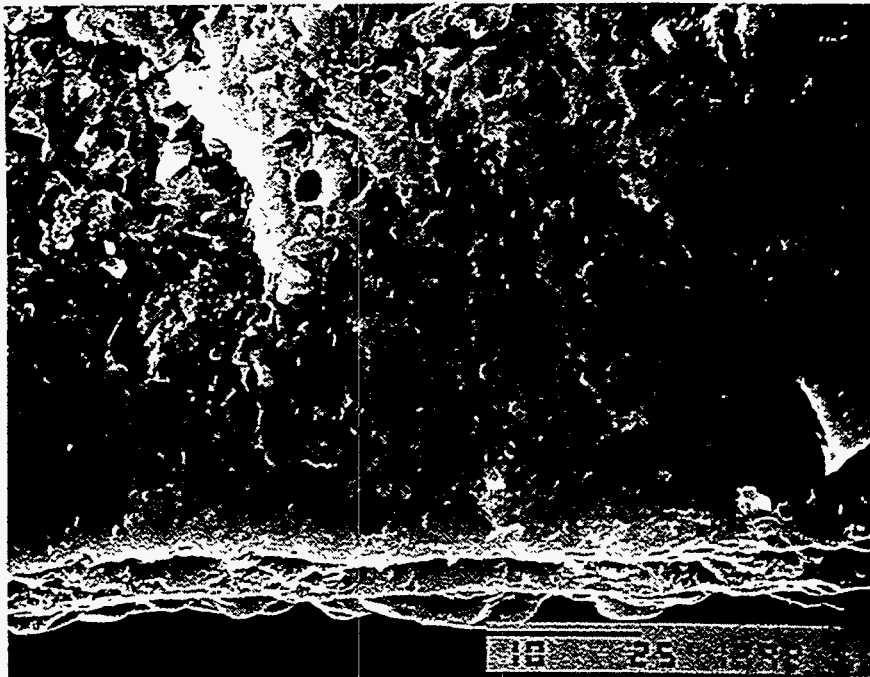
Oxidation Time: 100 hr

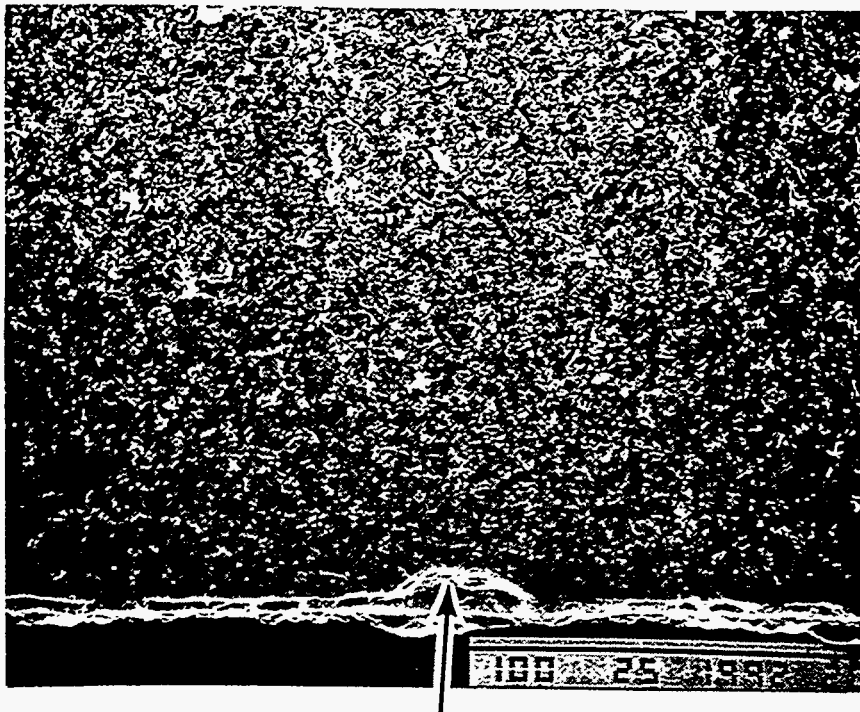




Specimen Number: 34.1572
Oxidation Temperature: 1371°C

Oxidation Time: 100 hr

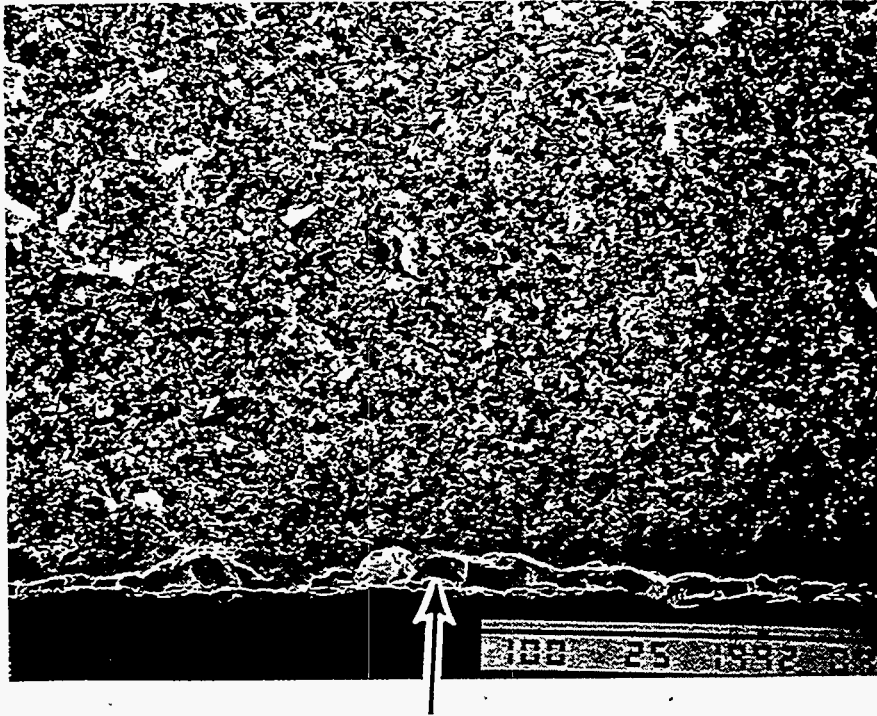




Specimen Number: 34.1573
Oxidation Temperature: 1371°C

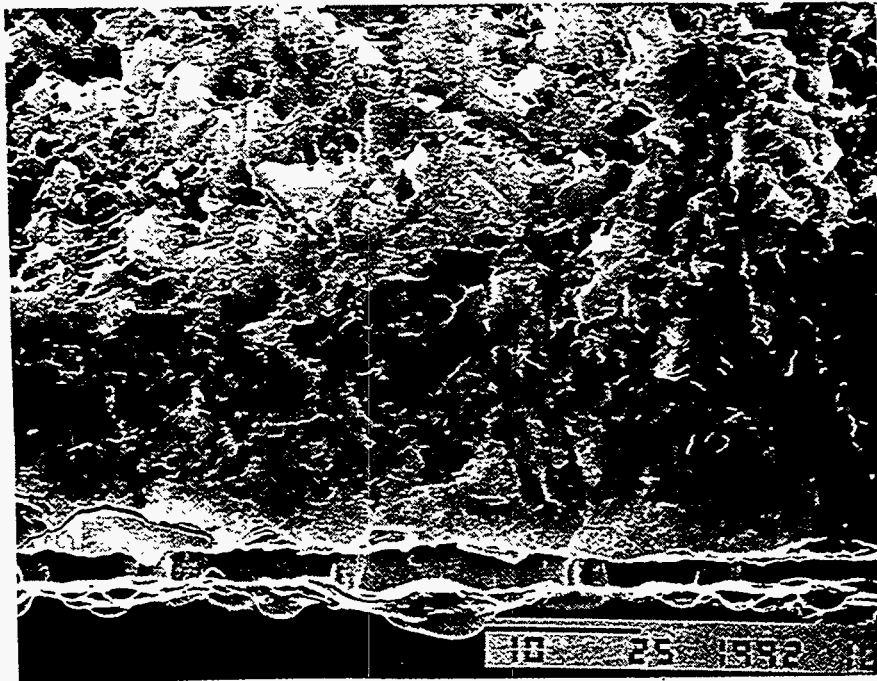
Oxidation Time: 100 hr





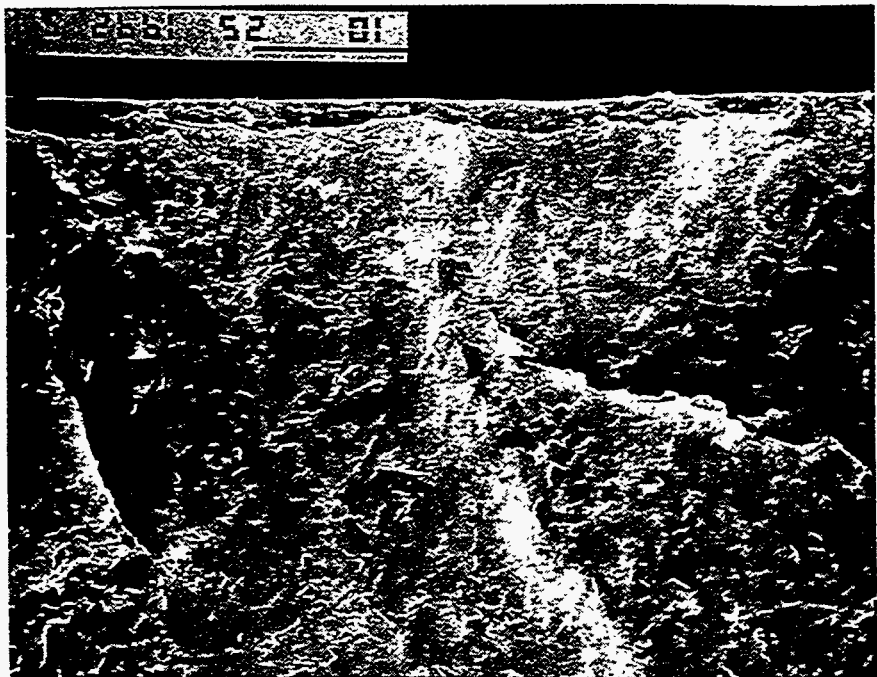
Specimen Number: 34.1574
Oxidation Temperature: 1371°C

Oxidation Time: 100 hr

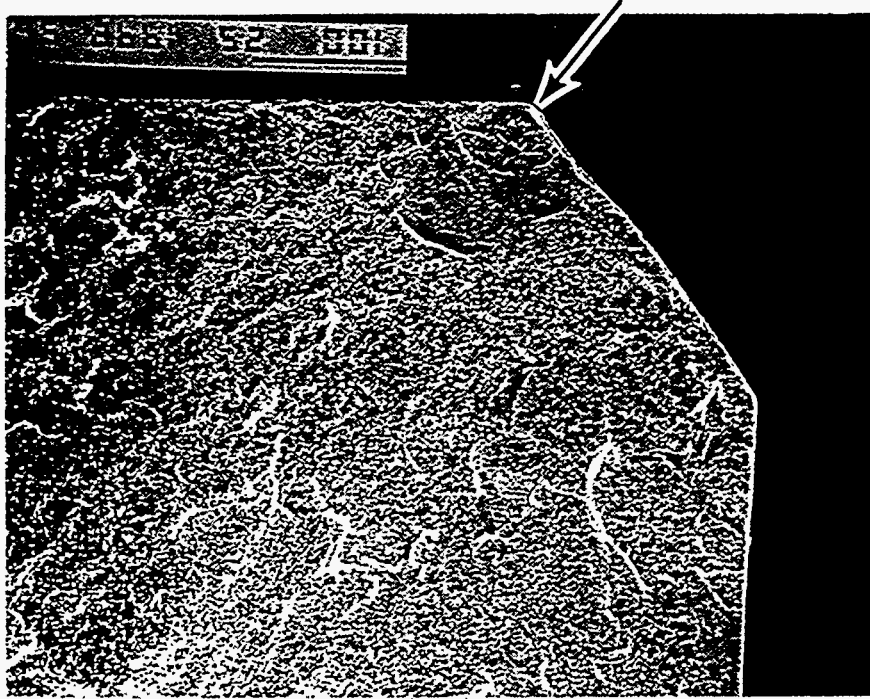


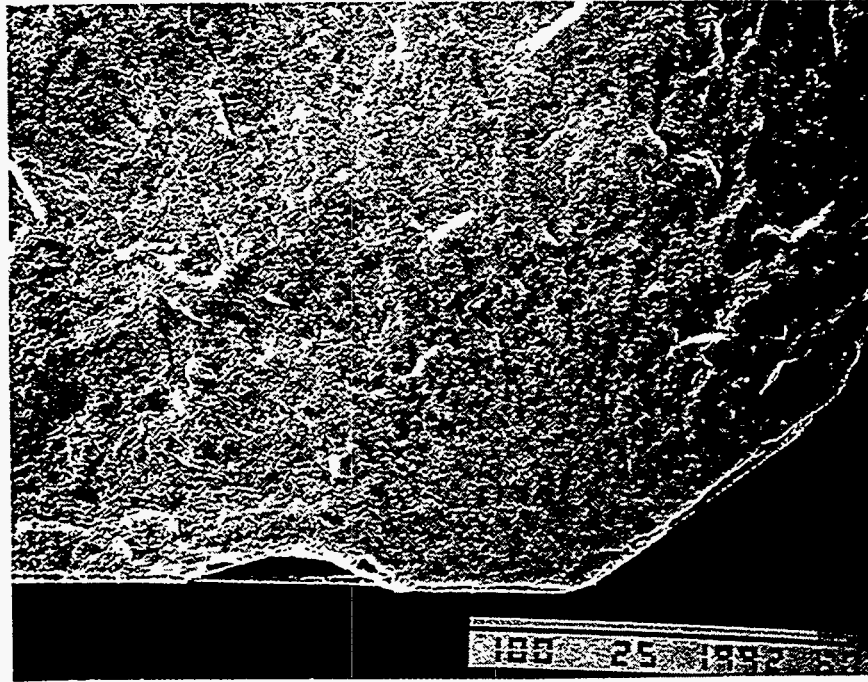
OXIDATION BEHAVIOR OF PY-6 SILICON NITRIDE AT 1400°C IN AIR





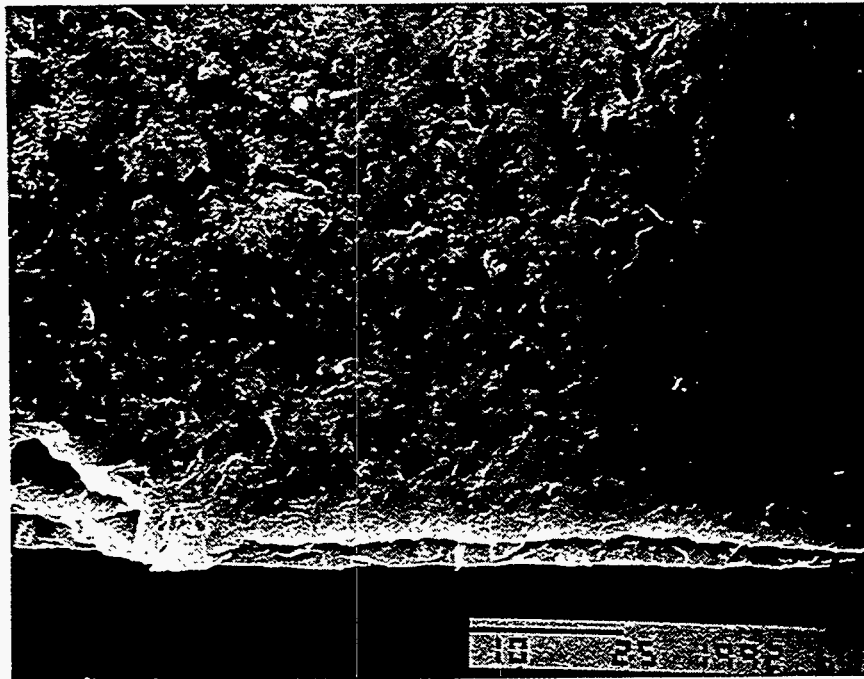
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Oxidation Temperature: 1400°C
Oxidation Time: 1 hr

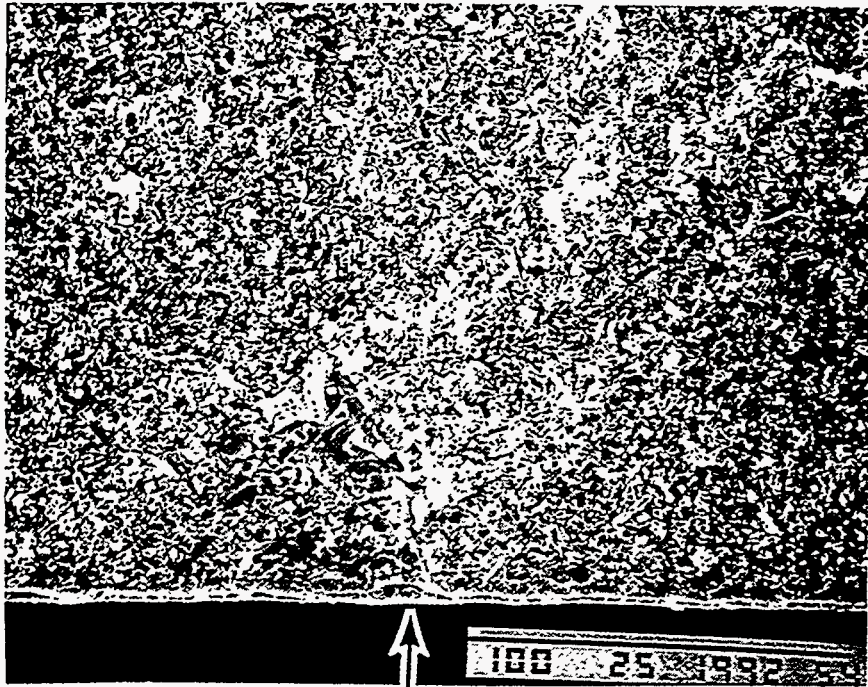




Specimen Number: 34.1554
Oxidation Temperature: 1400°C

Oxidation Time: 1 hr

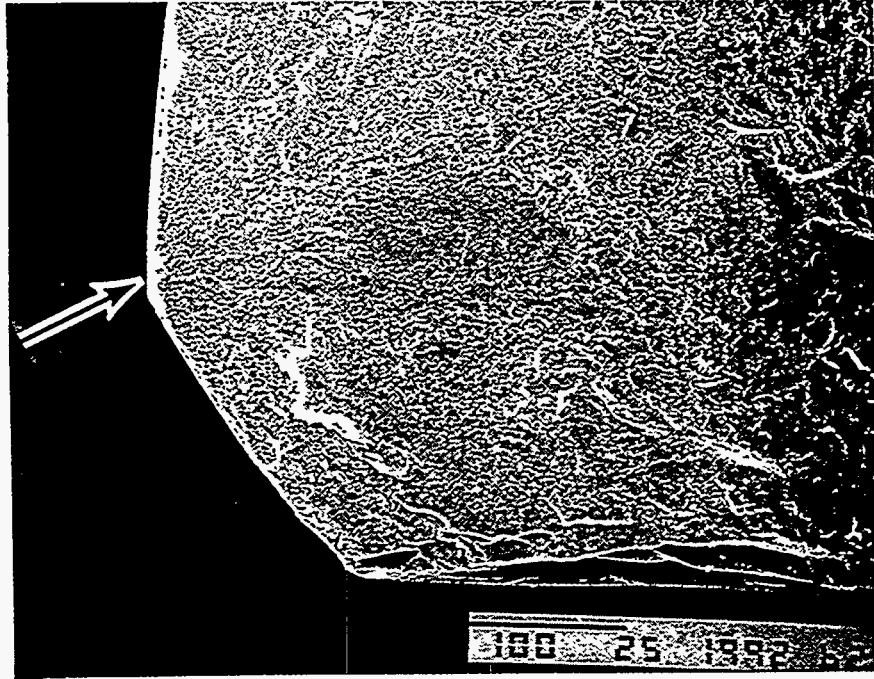




Specimen Number: 34.1553
Oxidation Temperature: 1400°C

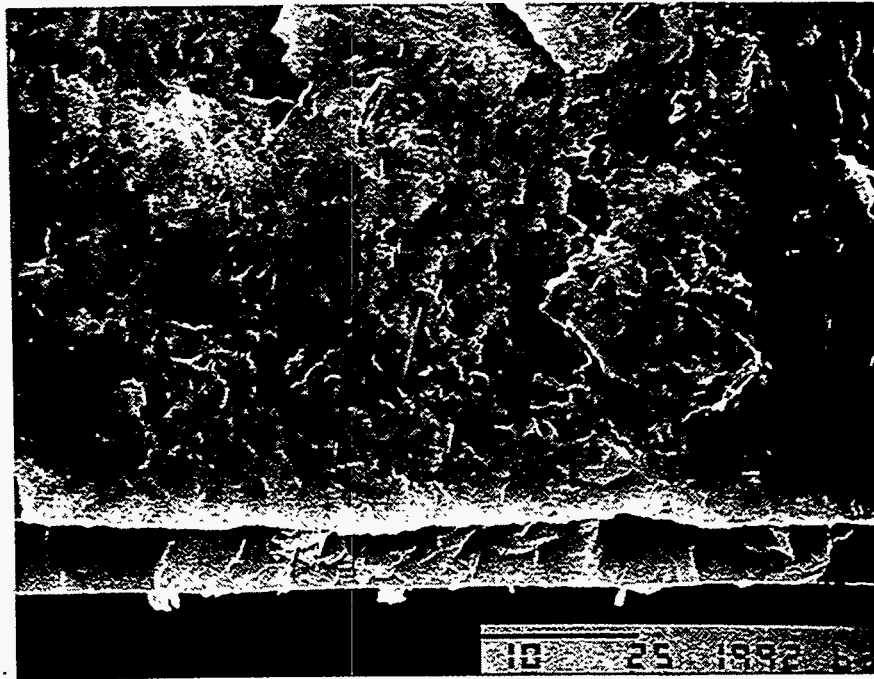
Oxidation Time: 1 hr

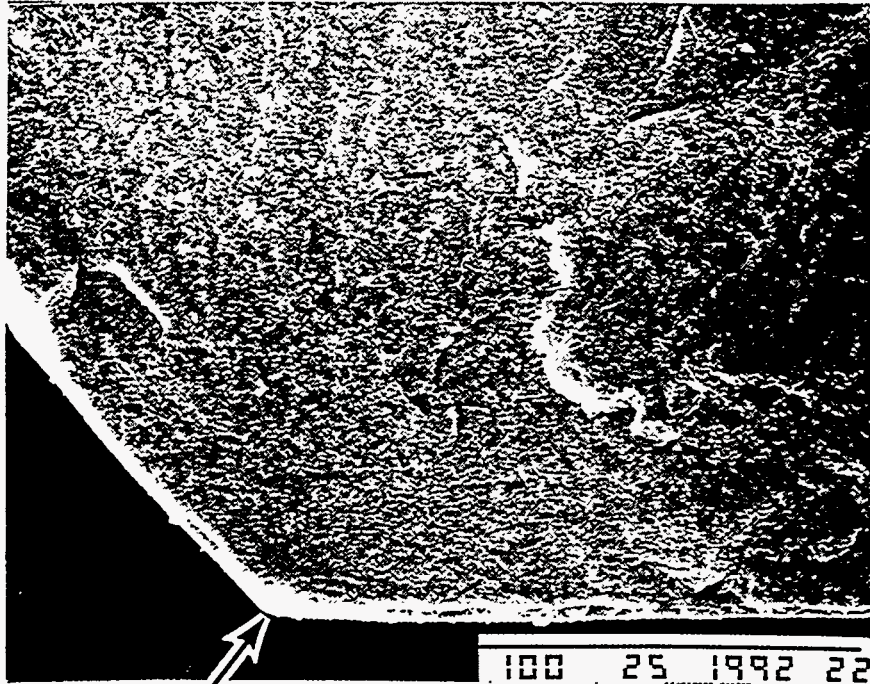




Specimen Number: 34.1552
Oxidation Temperature: 1400°C

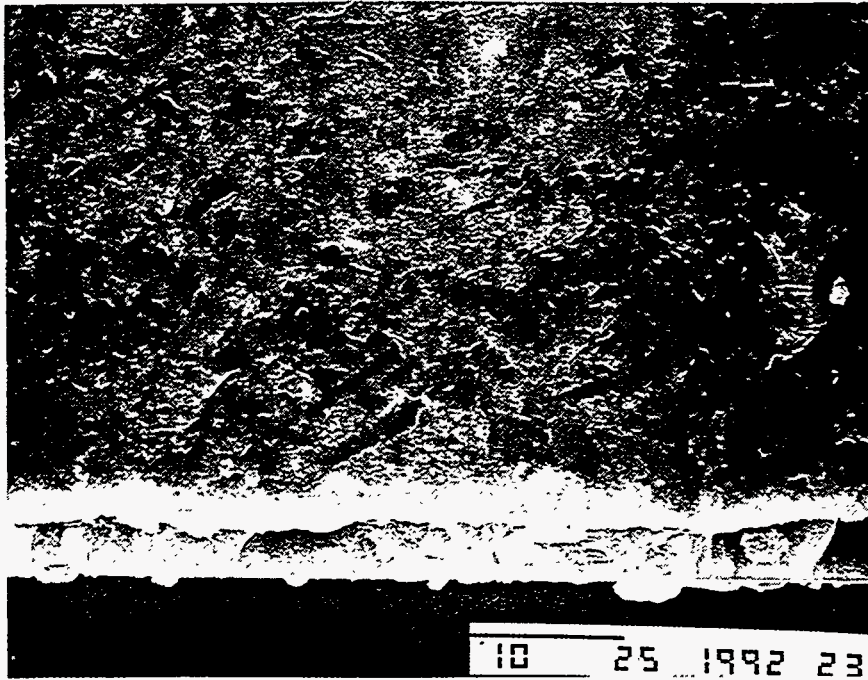
Oxidation Time: 1 hr

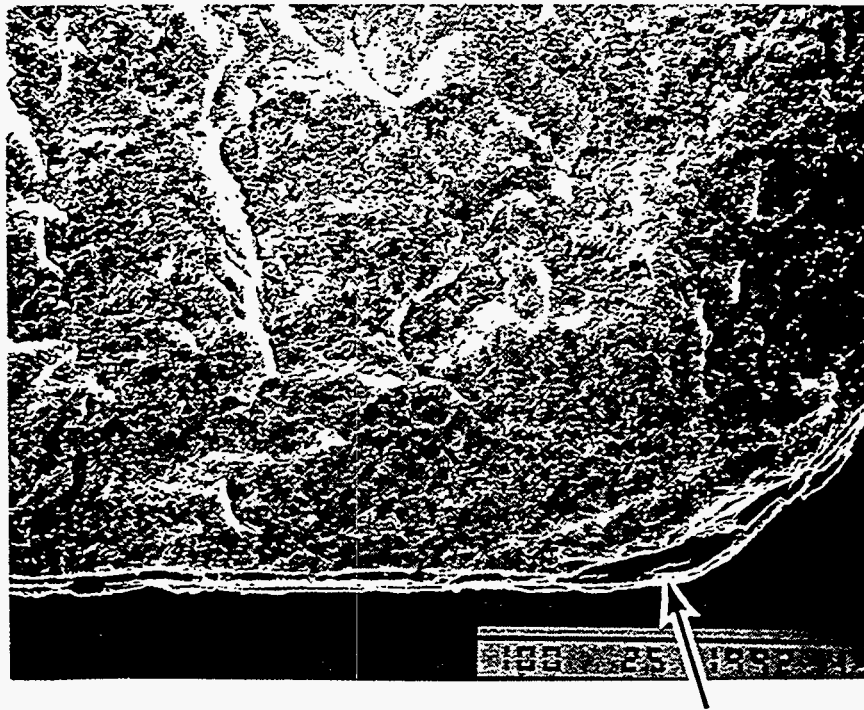




Specimen Number: 34.1551
Oxidation Temperature: 1400°C

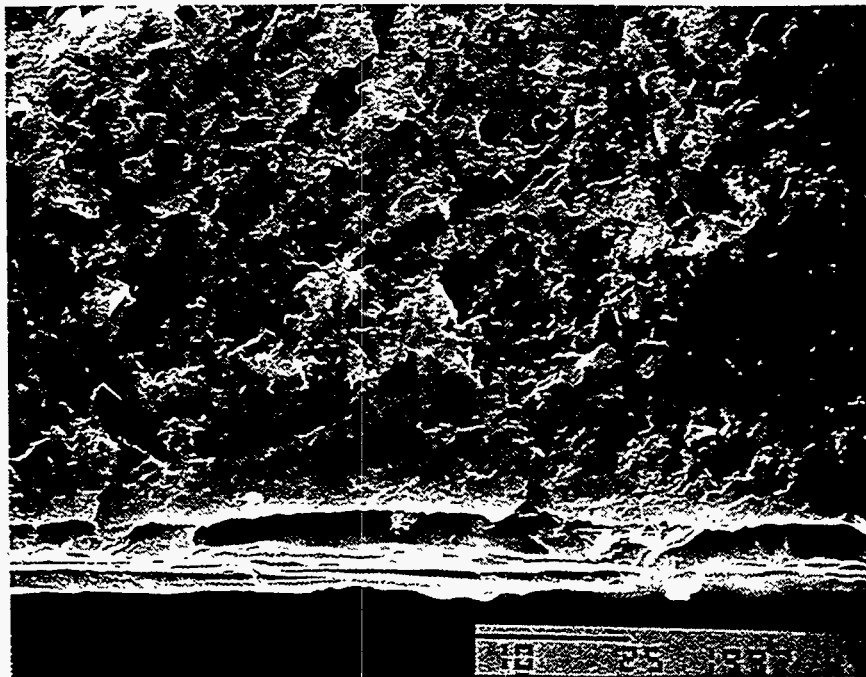
Oxidation Time: 1 hr

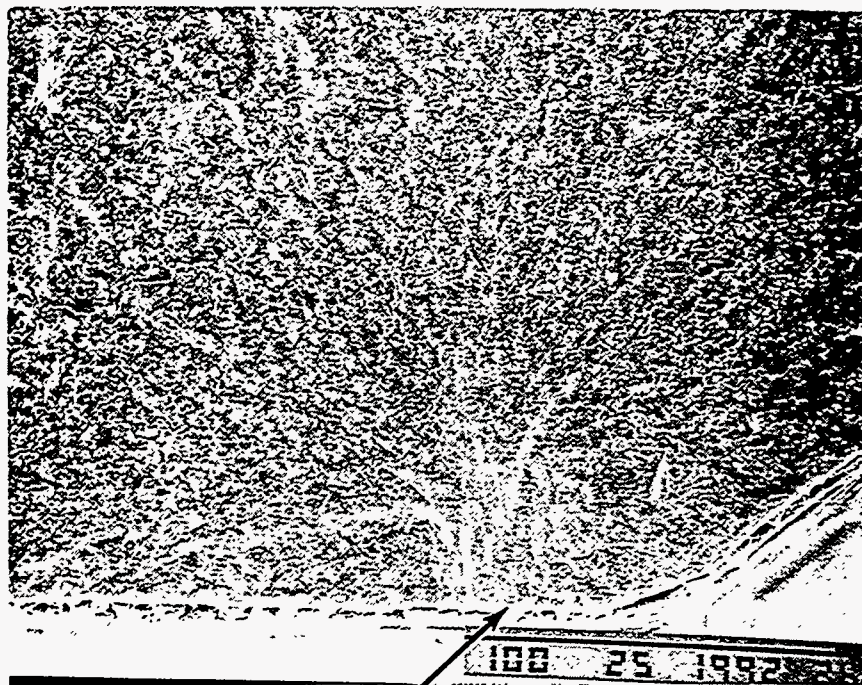




Specimen Number: 34.1562
Oxidation Temperature: 1400°C

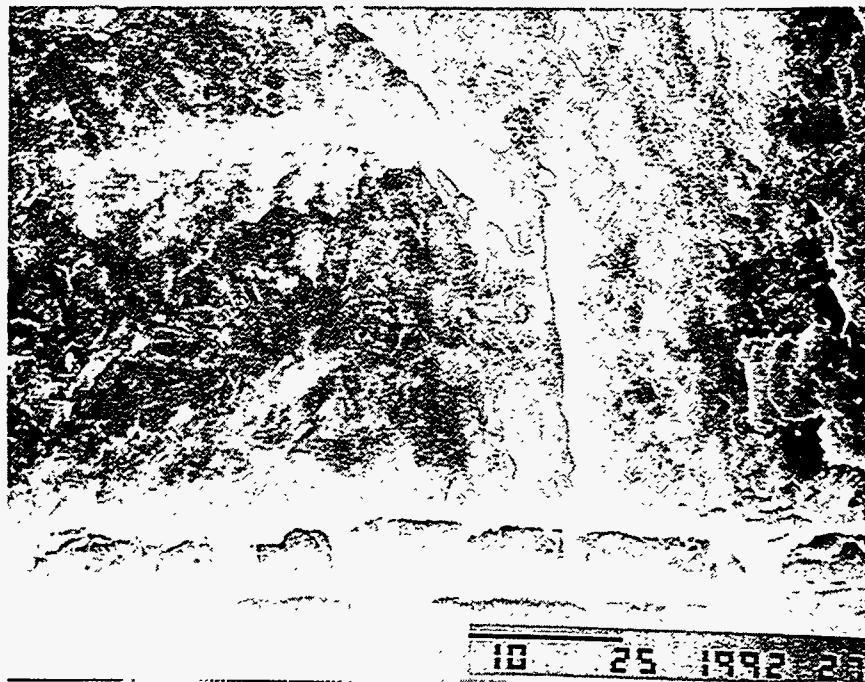
Oxidation Time: 3 hr





Specimen Number: 34.1563
Oxidation Temperature: 1400°C

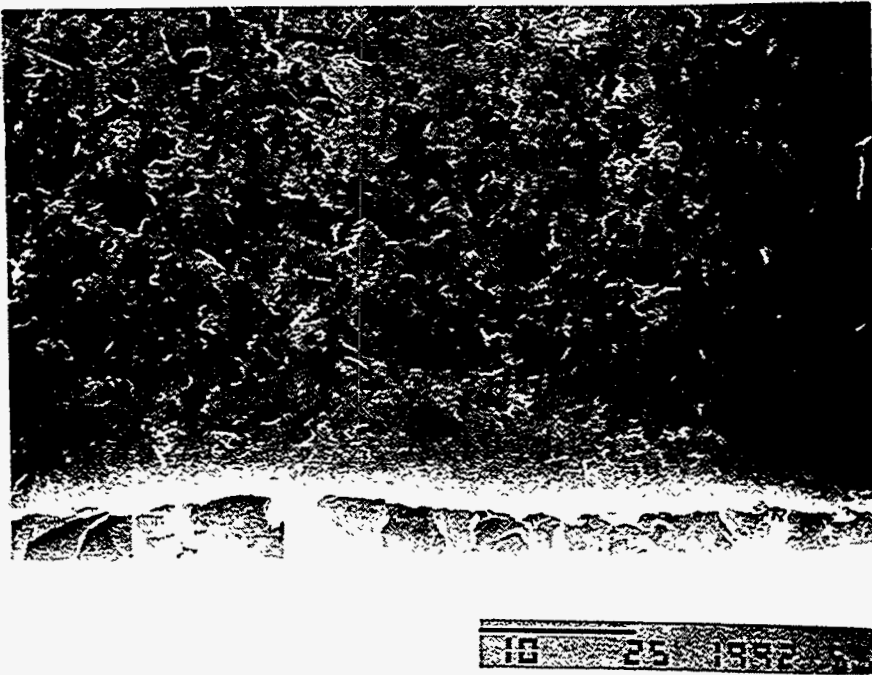
Oxidation Time: 3 hr

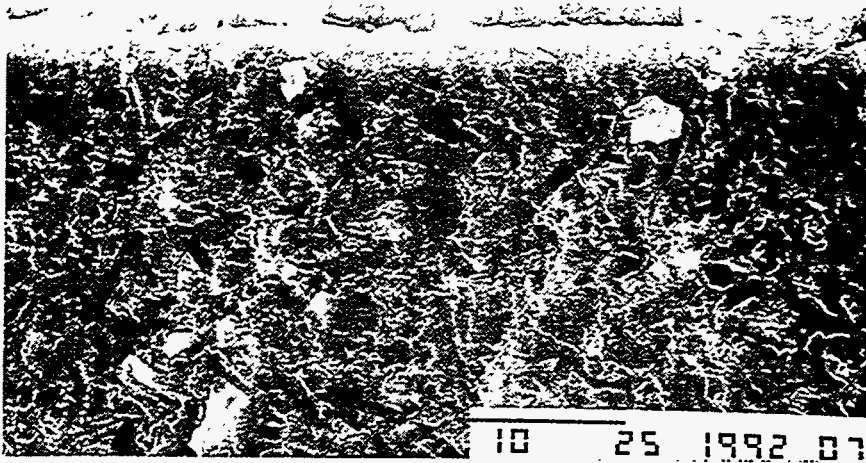




Specimen Number: 34.1564
Oxidation Temperature: 1400°C

Oxidation Time: 3 hr

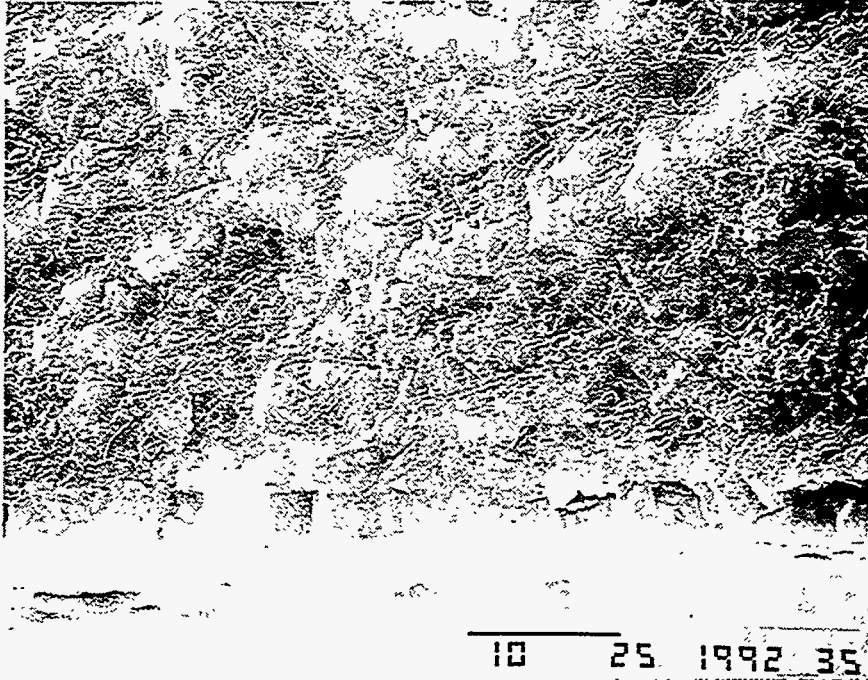




Specimen Number: 34.1565

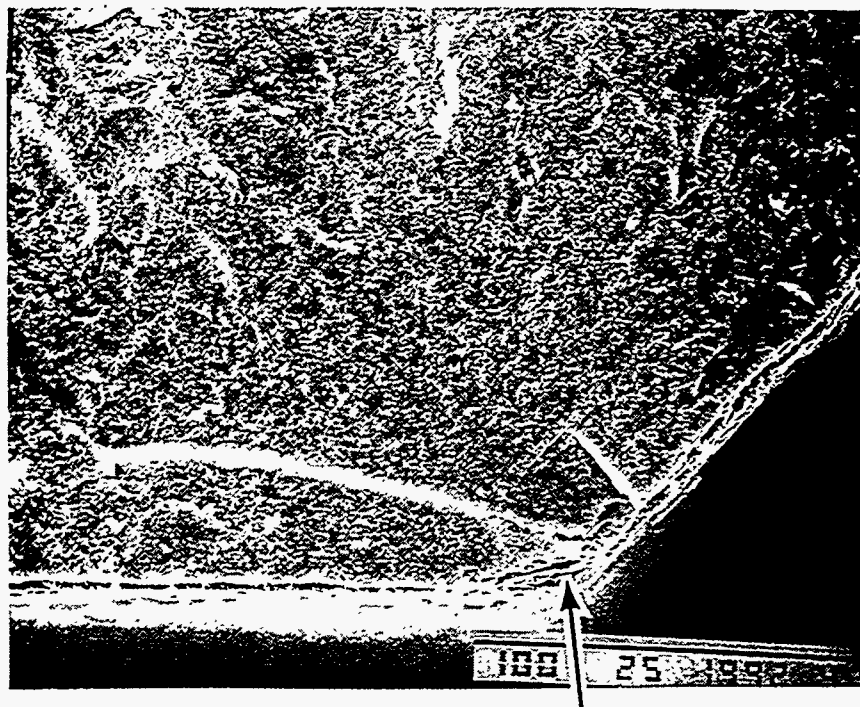
Oxidation Temperature: 1400°C

Oxidation Time: 3 hr



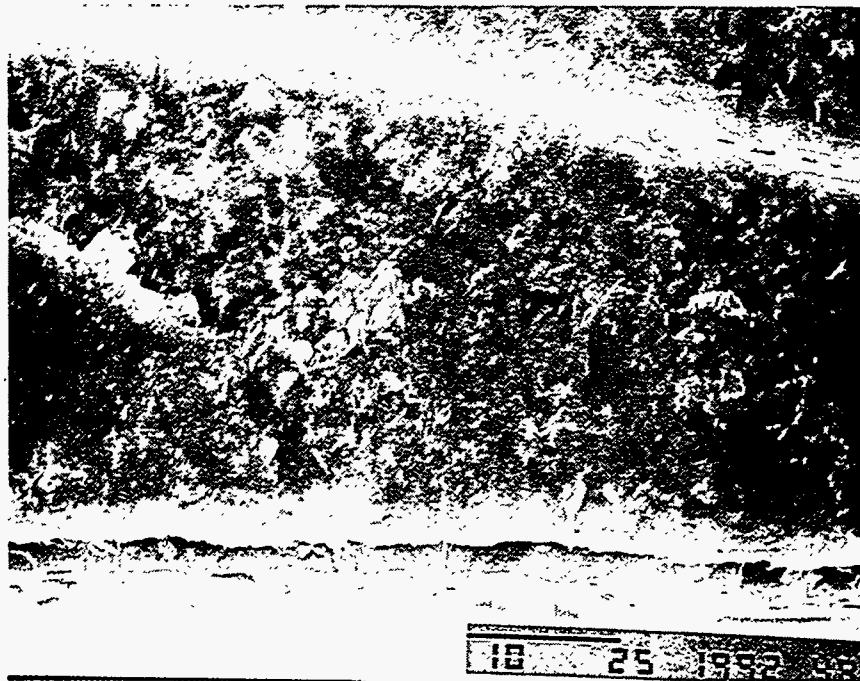
Specimen Number: 34.1495
Oxidation Temperature: 1400°C

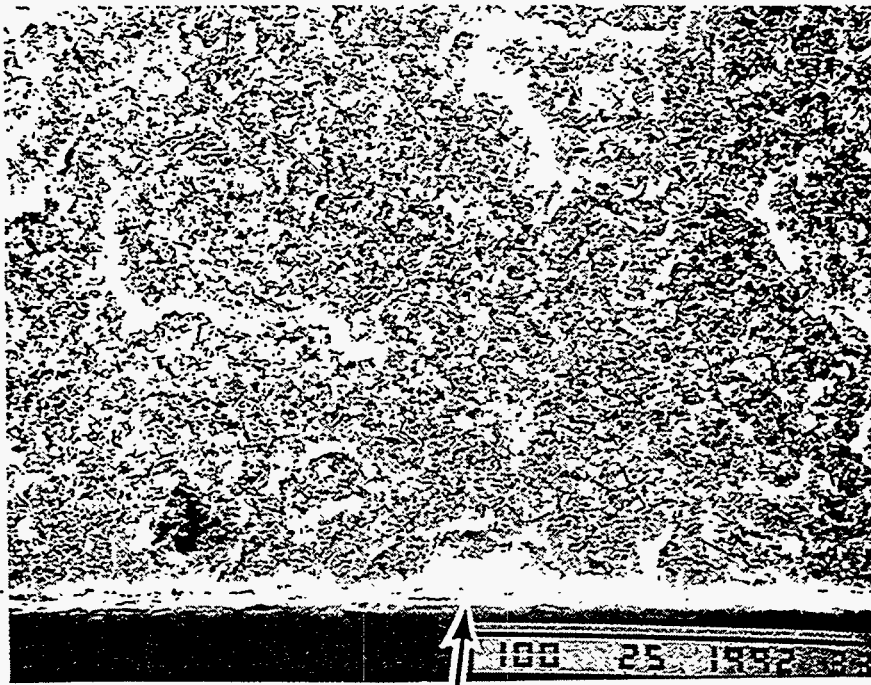
Oxidation Time: 6 hr



Specimen Number: 34.1496
Oxidation Temperature: 1400°C

Oxidation Time: 6 hr

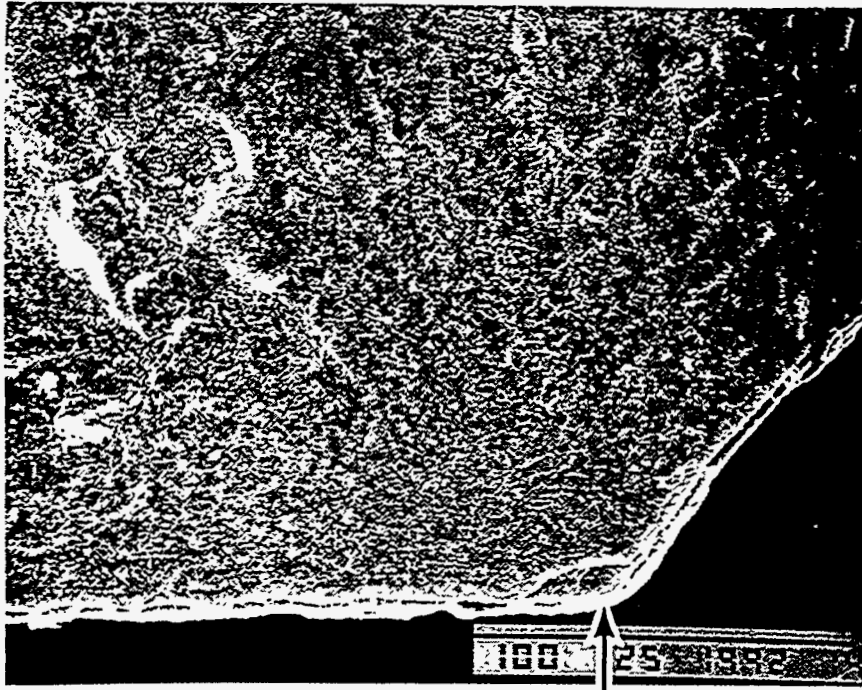




Specimen Number: 34.1497
Oxidation Temperature: 1400°C

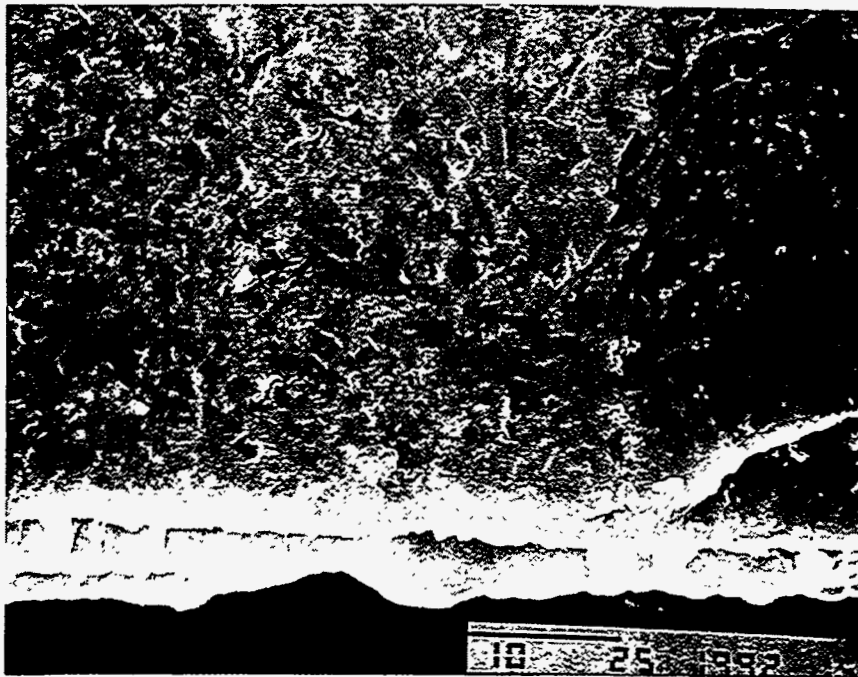
Oxidation Time: 6 hr

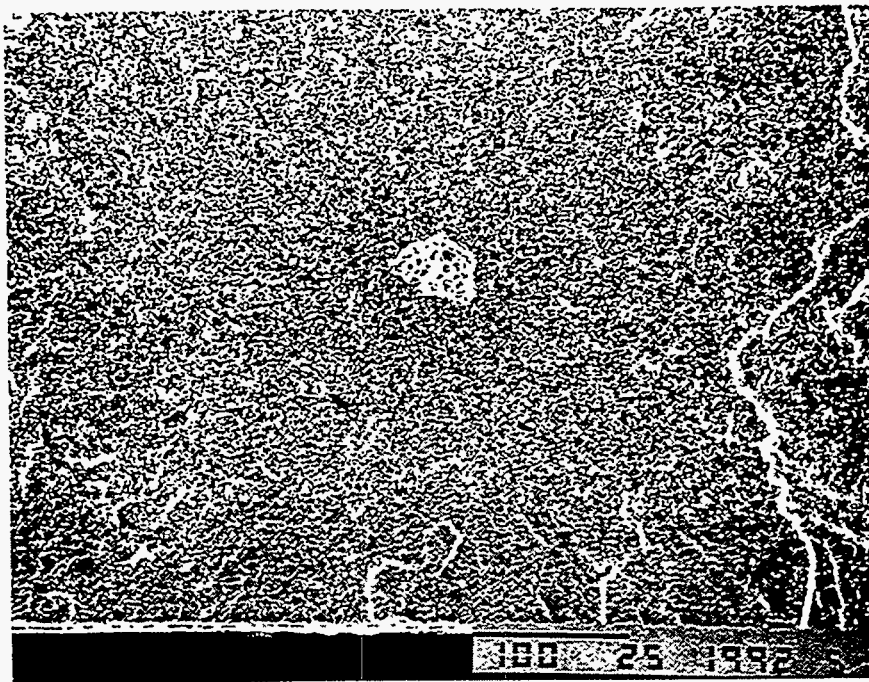




Specimen Number: 34.1498
Oxidation Temperature: 1400°C

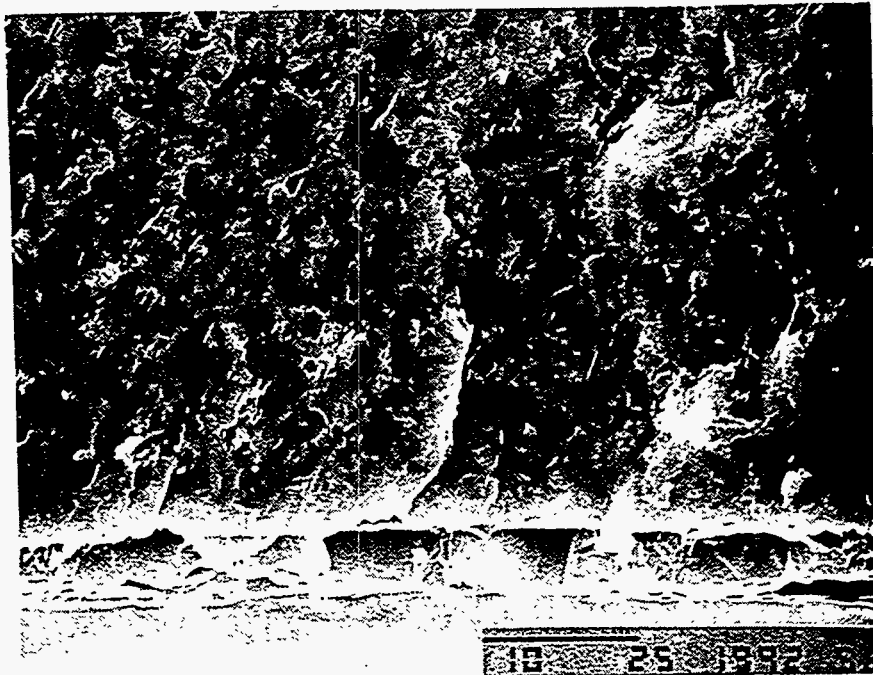
Oxidation Time: 6 hr

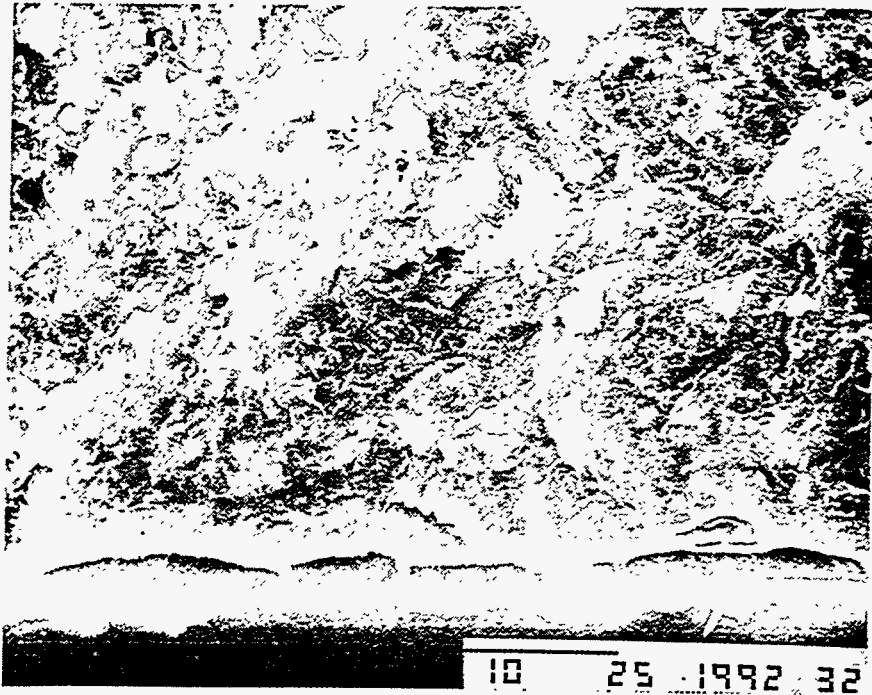




Specimen Number: 34.1499
Oxidation Temperature: 1400°C

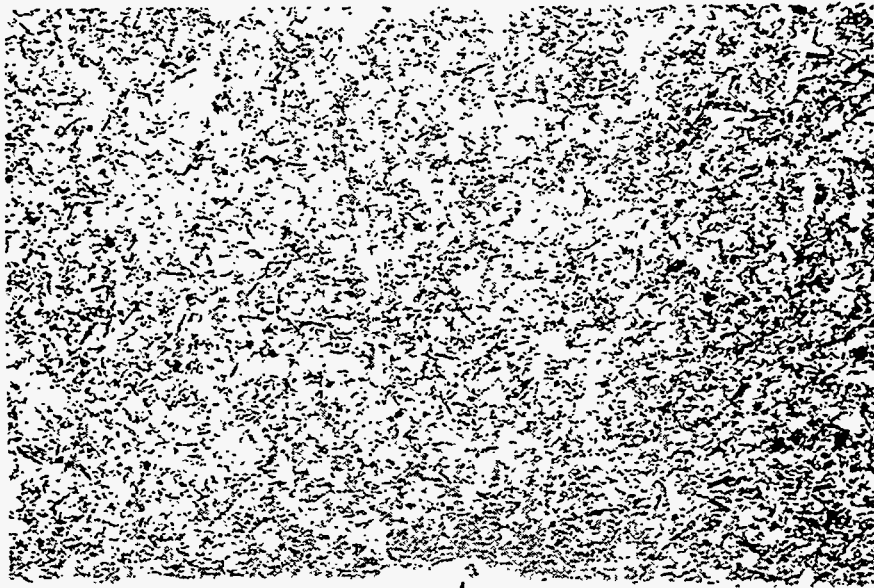
Oxidation Time: 6 hr





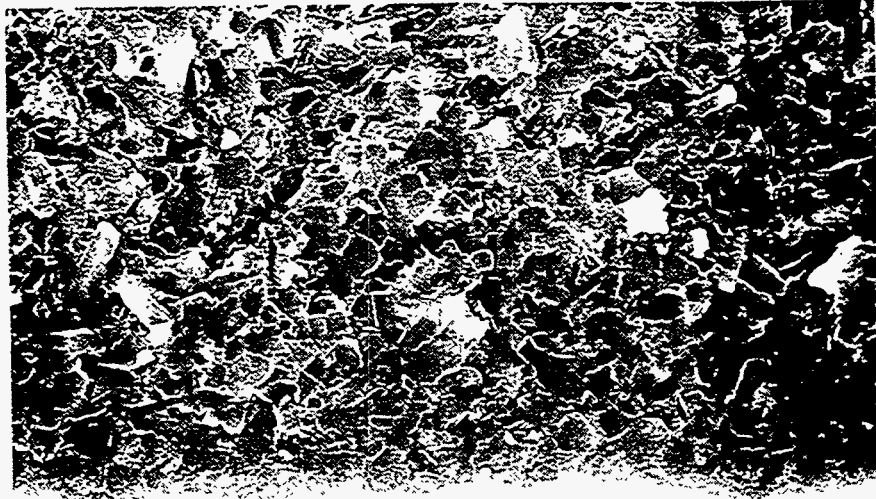
Specimen Number: 34.1490
Oxidation Temperature: 1400°C

Oxidation Time: 10 hr



Specimen Number: 34.1491
Oxidation Temperature: 1400°C

Oxidation Time: 10 hr

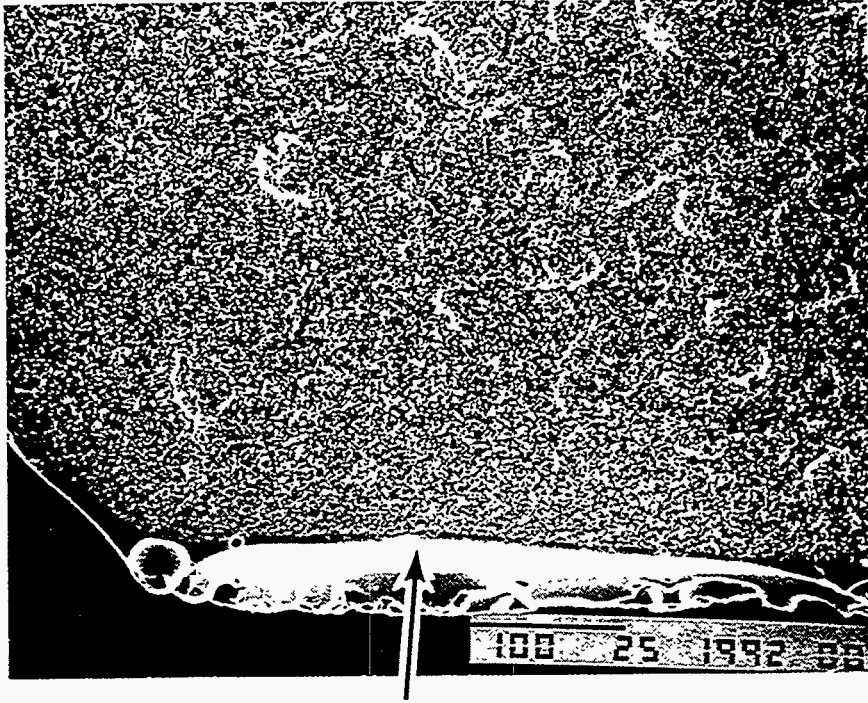




Specimen Number: 34.1492
Oxidation Temperature: 1400°C

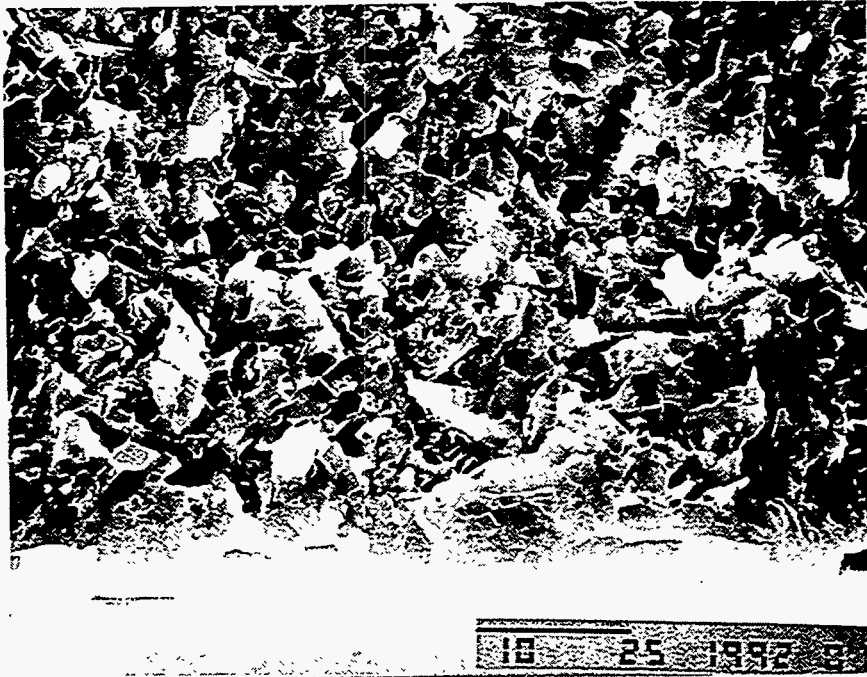
Oxidation Time: 10 hr

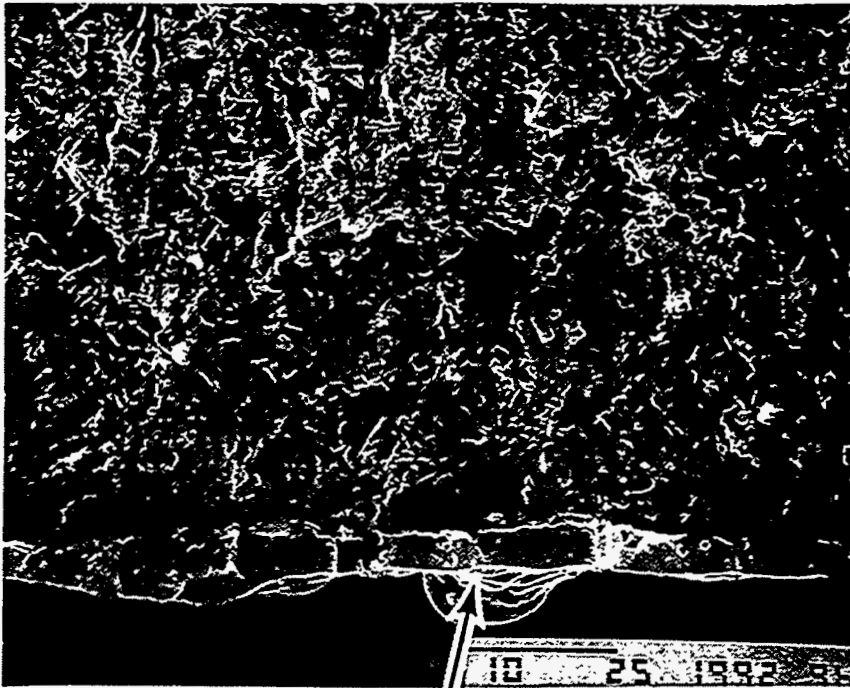




Specimen Number: 34.1494
Oxidation Temperature: 1400°C

Oxidation Time: 10 hr

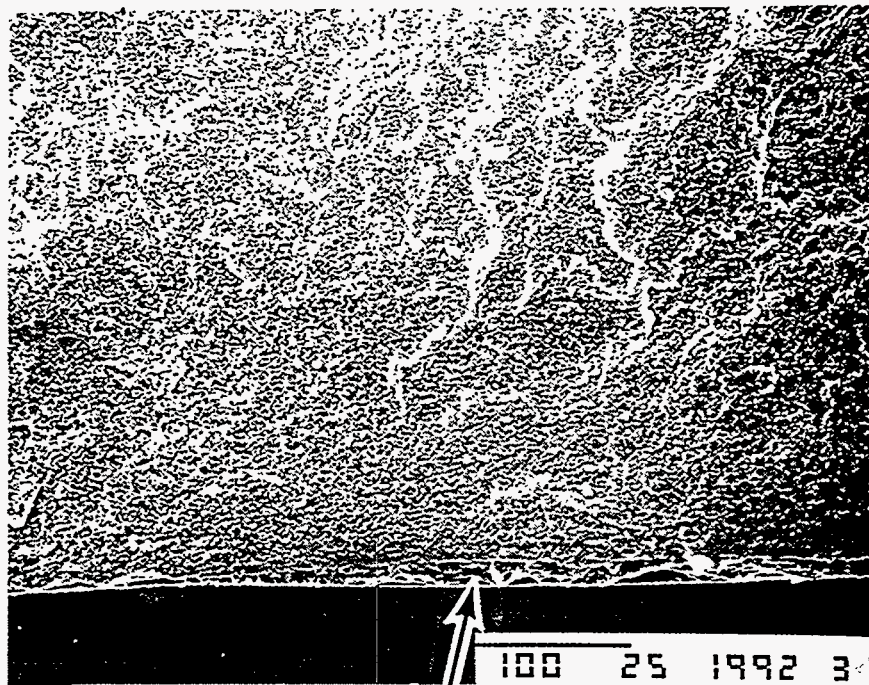




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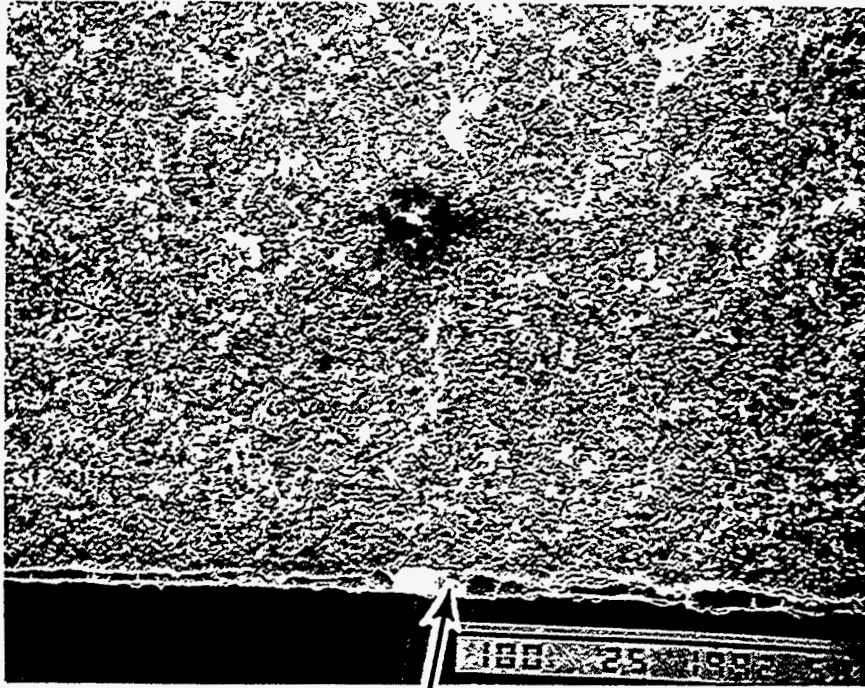
Oxidation Temperature: 1400°C

Oxidation Time: 50 hr



Specimen Number: 34.1490
Oxidation Temperature: 1400°C

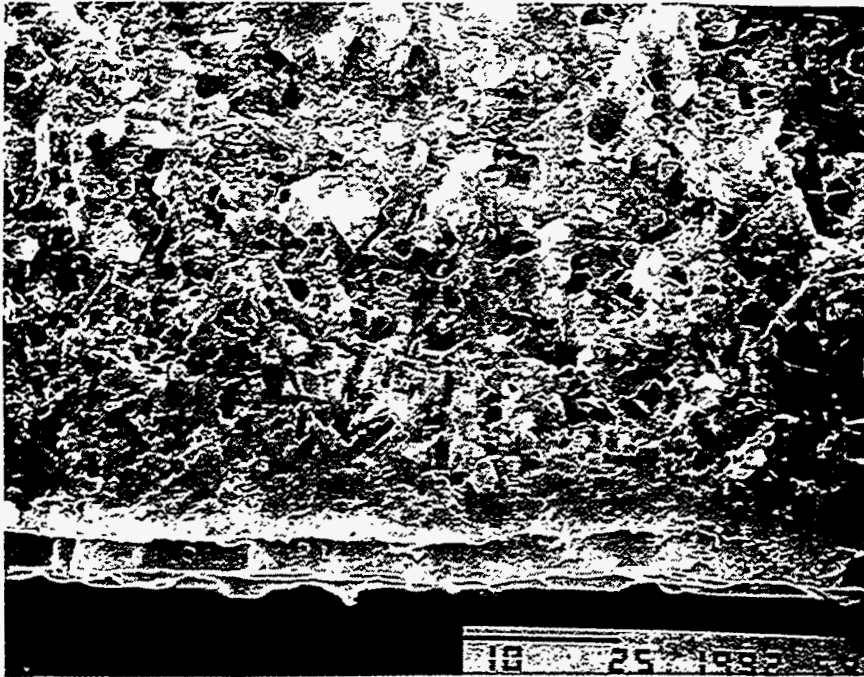
Oxidation Time: 50 hr

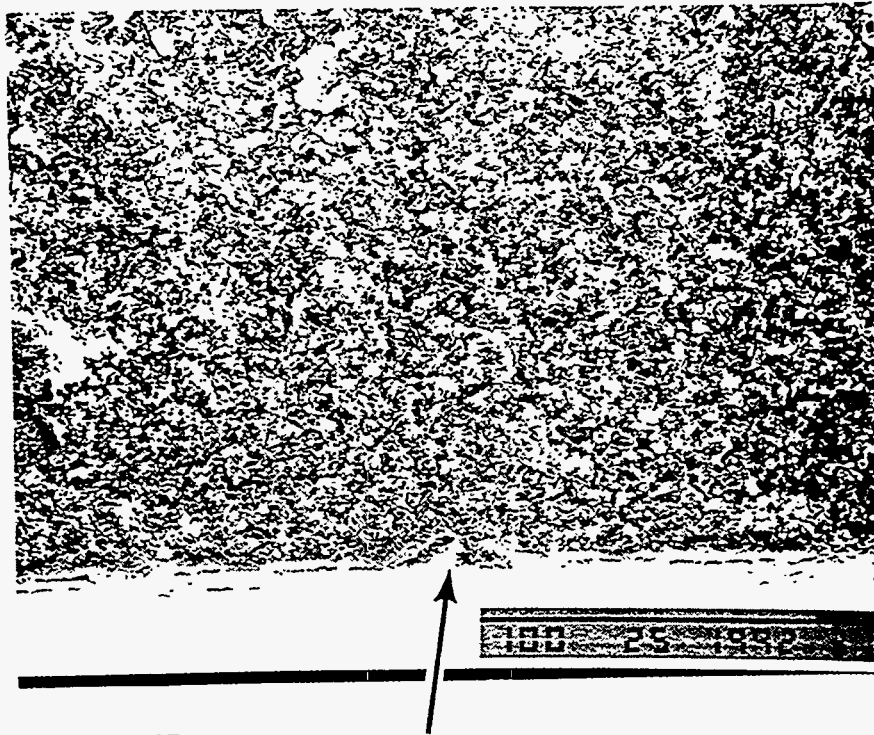


Specimen Number: 34.1486

Oxidation Temperature: 1400°C

Oxidation Time: 50 hr

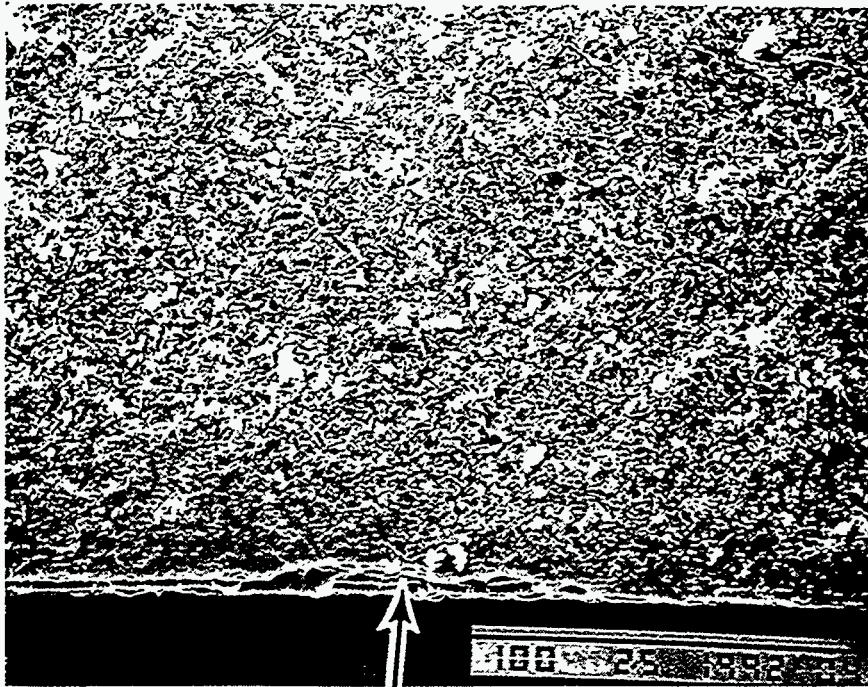




Specimen Number: 34.1487
Oxidation Temperature: 1400°C

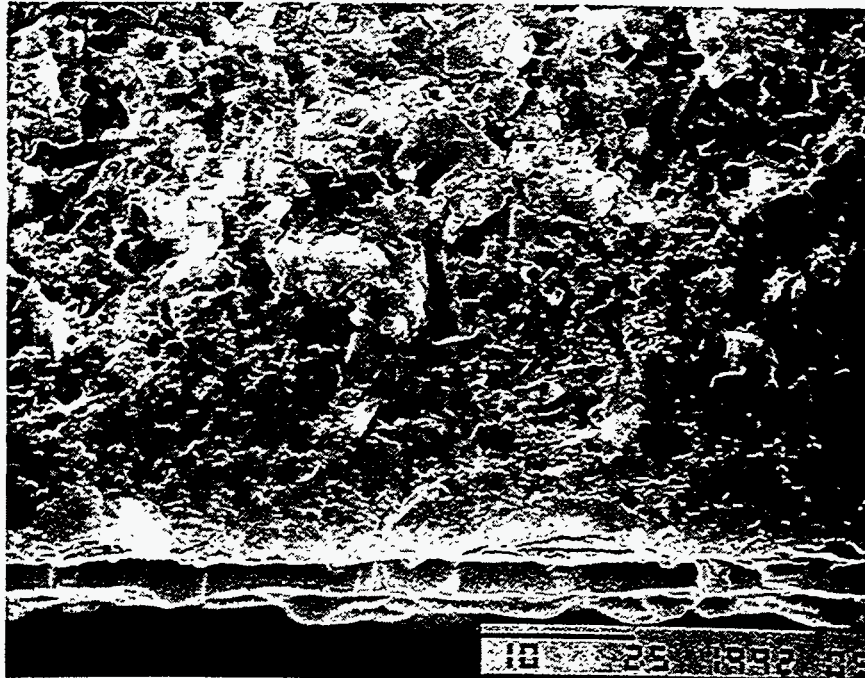
Oxidation Time: 50 hr

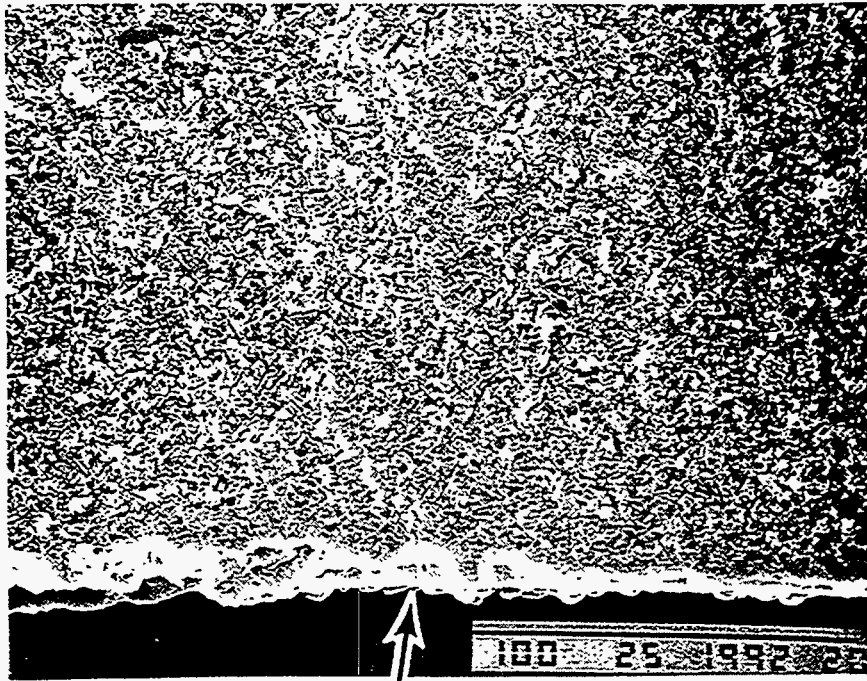




Specimen Number: 34.1488
Oxidation Temperature: 1400°C

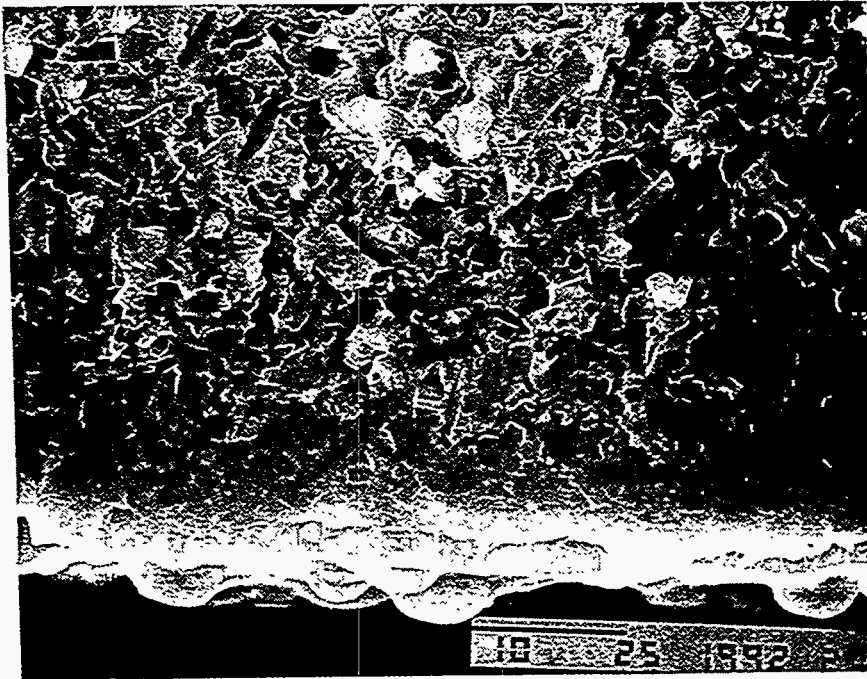
Oxidation Time: 50 hr

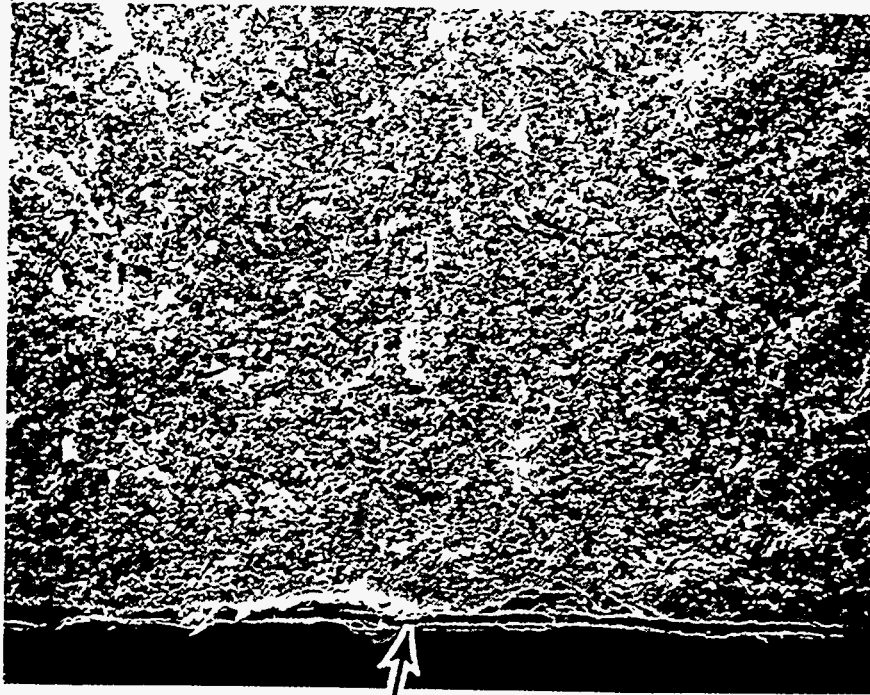




Specimen Number: 34.1489
Oxidation Temperature: 1400°C

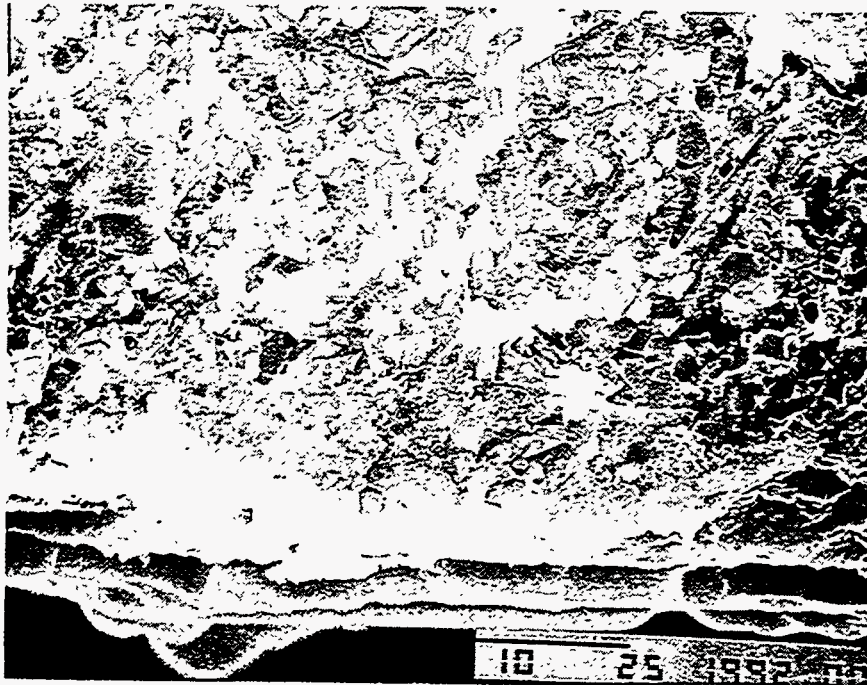
Oxidation Time: 50 hr

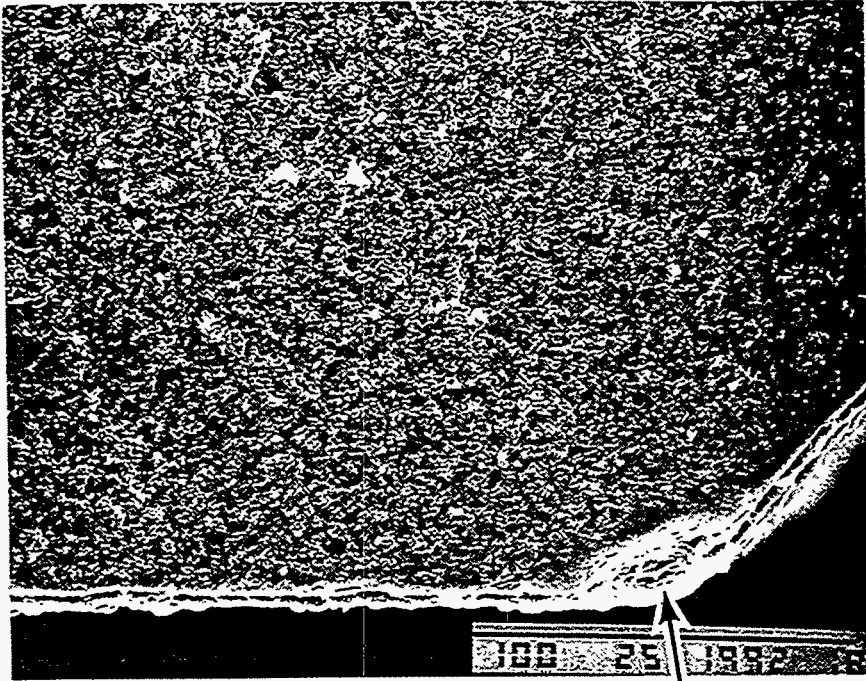




Specimen Number: 34.1480
Oxidation Temperature: 1400°C

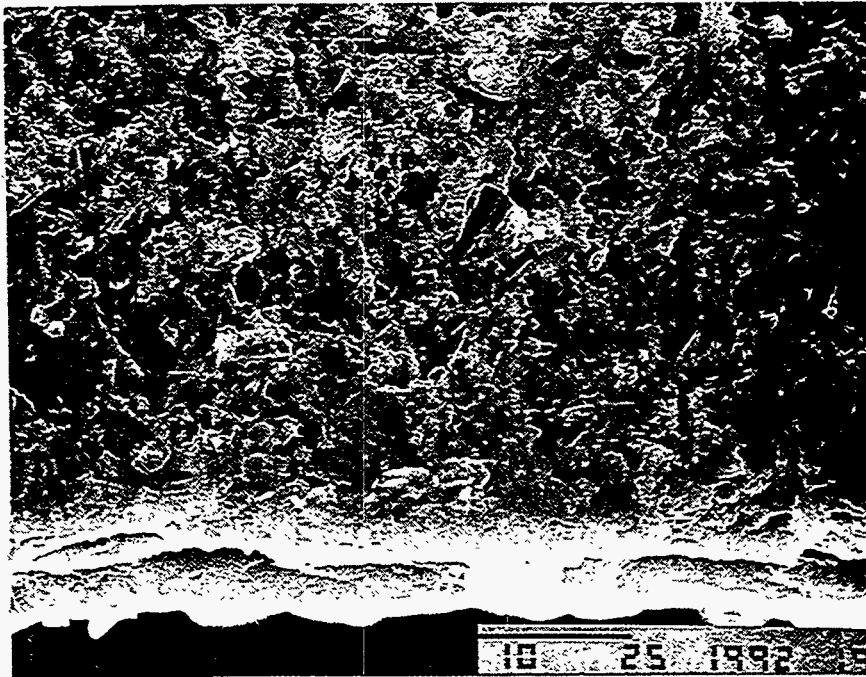
Oxidation Time: 100 hr

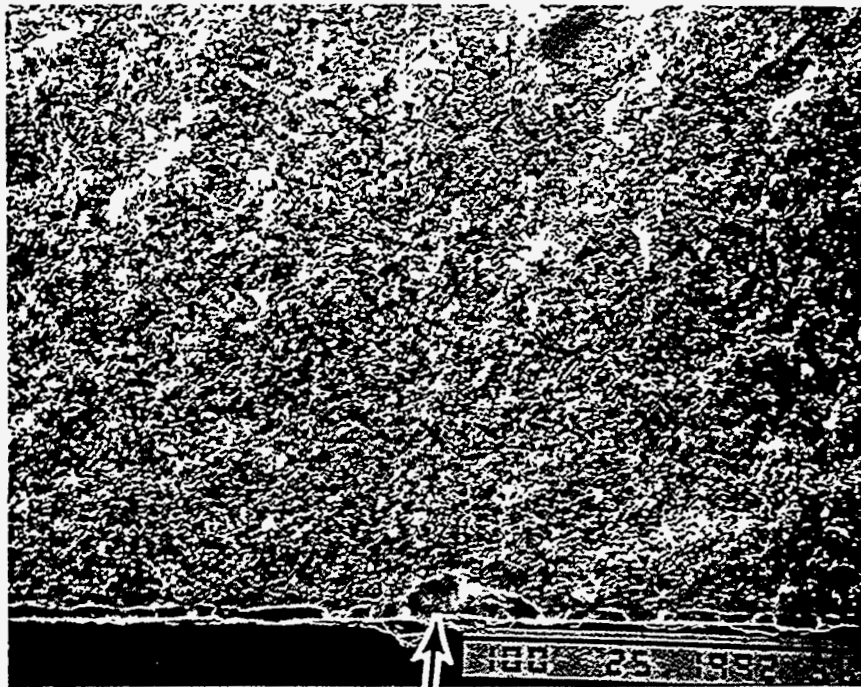




Specimen Number: 34.1481
Oxidation Temperature: 1400°C

Oxidation Time: 100 hr

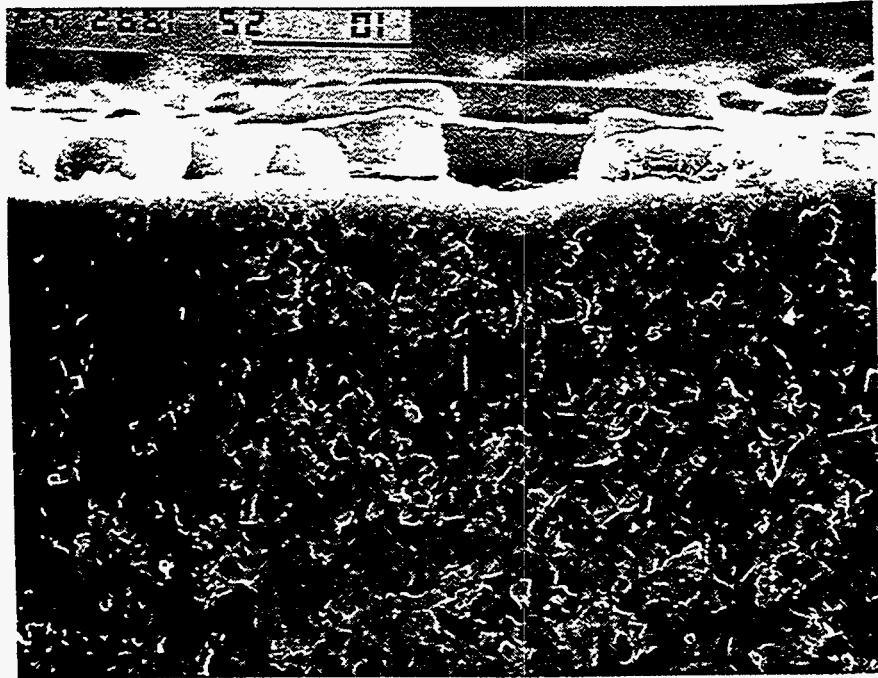




Specimen Number: 34.1482
Oxidation Temperature: 1400°C

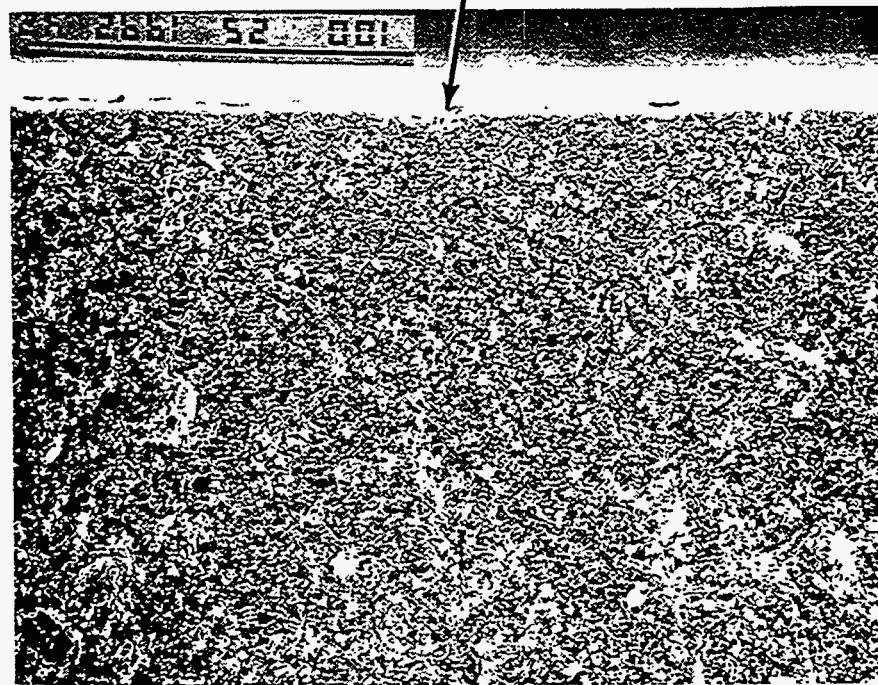
Oxidation Time: 100 hr

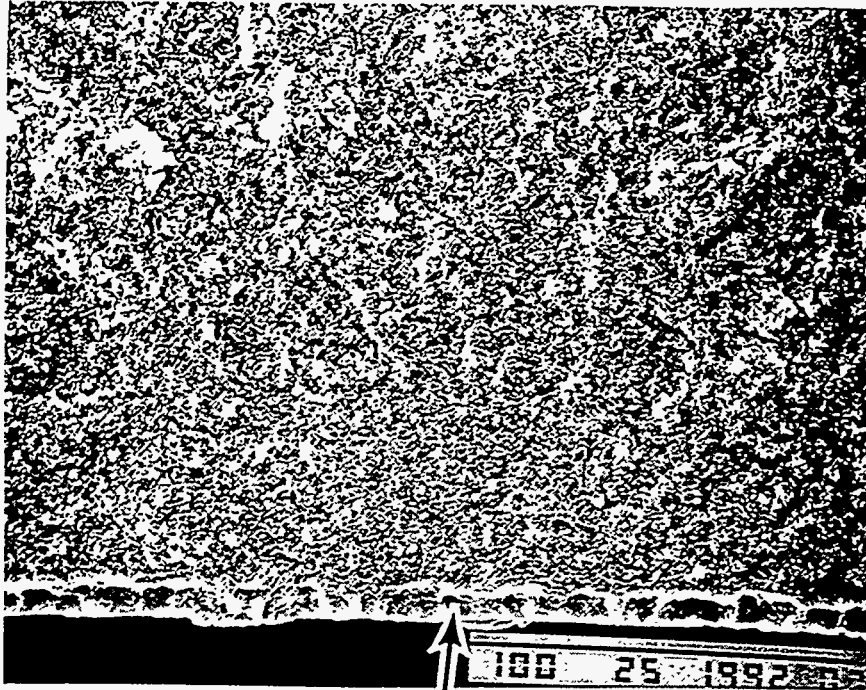




Oxidation Time: 100 hr

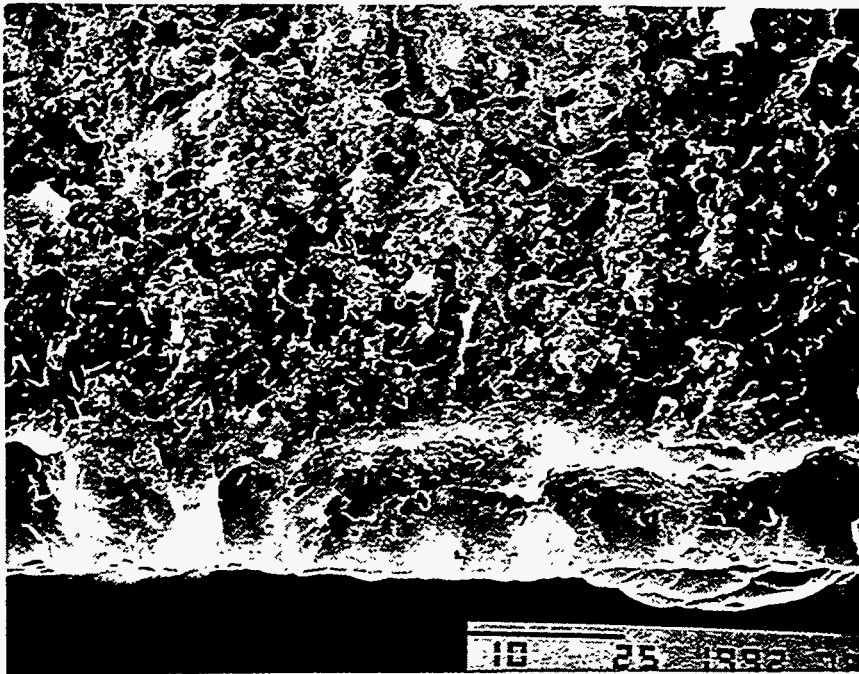
Specimen Number: 34.1483
Oxidation Temperature: 1400°C

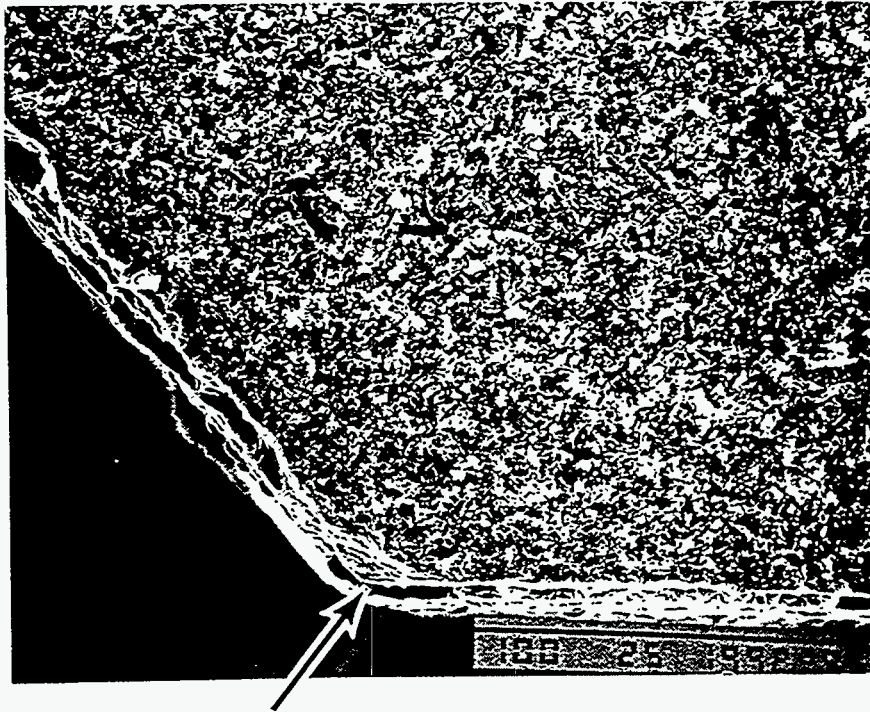




Specimen Number: 34.1557
Oxidation Temperature: 1400°C

Oxidation Time: 500 hr

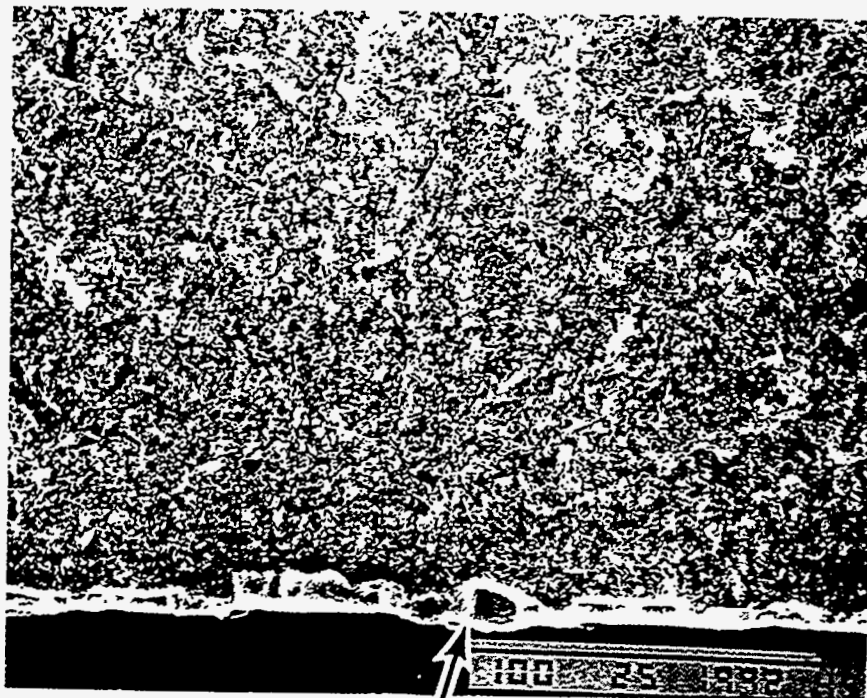




Specimen Number: 34.1559
Oxidation Temperature: 1400°C

Oxidation Time: 500 hr

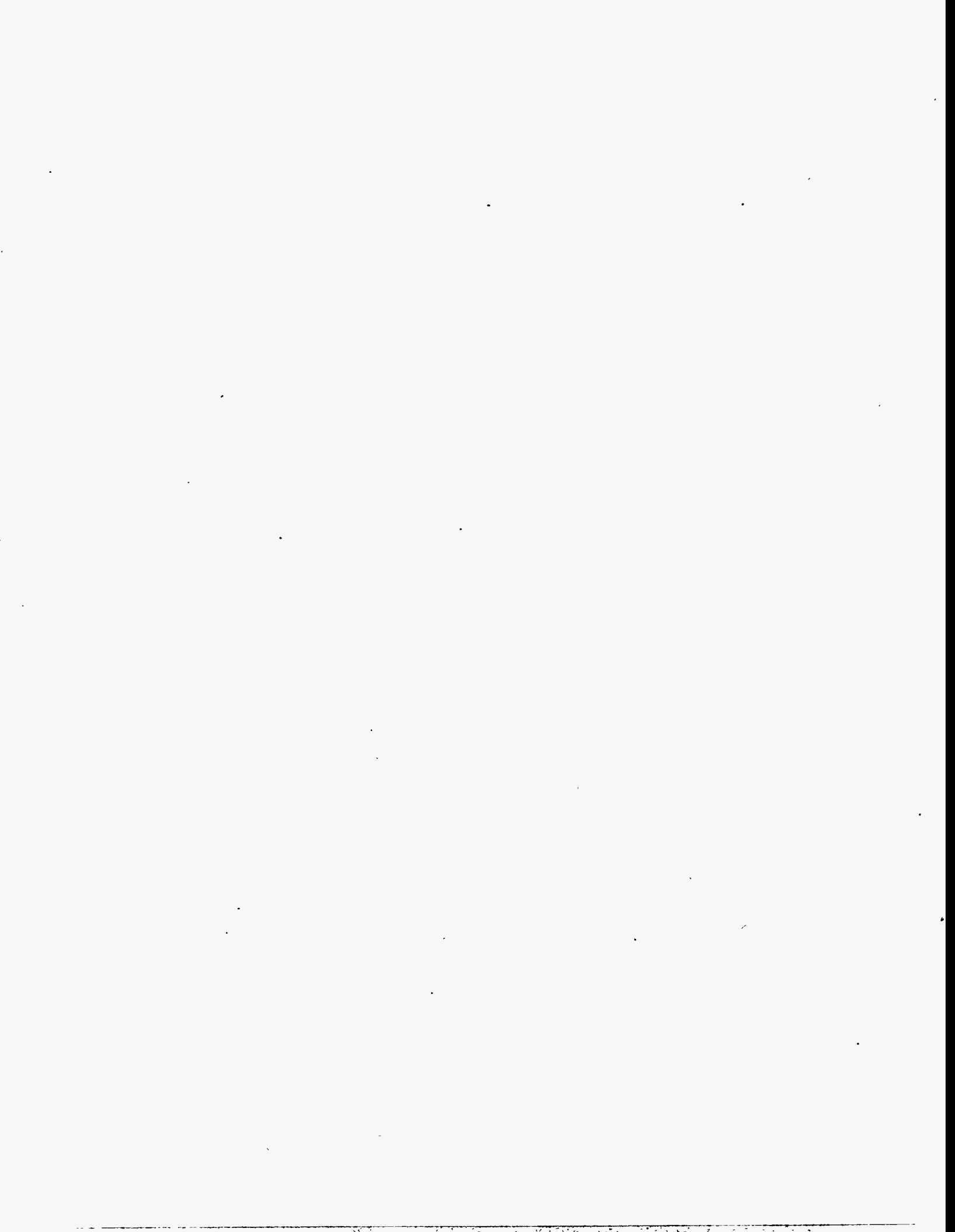




Specimen Number: 34.1560
Oxidation Temperature: 1400°C

Oxidation Time: 500 hr





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