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EFFECT OF BOND COAT CREEP AND OXIDATION ON TBC INTEGRITY

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The potential of thermal barrier coatings (TBC's) on high-pressure turbine (HPT) nozzles and blades is limited at present by the inability to quantitatively predict TBC life for these components. The goal of the work described here was to isolate the major TBC failure mechanisms, which is part of a larger program aimed at developing TBC life prediction models. Based on the results of experiments to isolate TBC failure mechanisms, the effects of bond coat oxidation and bond coat creep on TBC integrity is discussed. In bond coat oxidation experiments, Rene' 80 specimens coated with a NiCrAlY/ZrO_2-8% Y_2O_3 TBC received isothermal pre-exposures at 2000 °F in static argon, static air, or received no pre-exposure. The effects of oxidation due to these pre-exposures were determined by thermal cycle tests in both static air and static argon at 2000 °F. To study the effect of bond coat creep on TBC behavior, four bond coats with different creep properties were evaluated by thermal cycle tests in air at 2000 °F. The test results, the relative importance of these two failure mechanisms, and how their effects may be quantified will also be discussed.

TABLE I.

MAIN THERMAL BARRIER COATING SYSTEM (weight percent)

Substrate(Rene' 80)	:	Ni-14Cr-9.5Co-5Ti-4Mo-3Al-0.17C-0.03Zr-0.015B
Bond Coating	:	Ni-22Cr-10Al-0.3Y (Low Pressure Plasma Spray)
Top Coating	:	ZnO_2 - $8Y_2O_3$ (Air Plasma Spray)

TABLE II.

BOND COAT CREEP SYSTEMS

Systems	Substrate/Bond Coating/Over Coating/Top Coating	Bond Coat Creep Strength
1	Rene' 80 / Ni-Cr-Al-Y / Aluminide / ZrO_2-Y_2O_3	Low
2	Rene' 80 / Superalloy 1/ Aluminide / ZrO_2-Y_2O_3	
3	Rene' 80 / Superalloy 2/ Aluminide / ZrO_2-Y_2O_3	
4	Rene' 80 / Superalloy 3/ Aluminide / ZrO_2-Y_2O_3	High

1. DETERMINE THERMAL BARRIER COATING FAILURE MECHANISMS

   -- Bond Coat Oxidation

   -- Bond Coat Creep

2. Thermal Barrier Coating Life Prediction Model

   -- Failure Mechanisms

   -- Key Mechanical Properties

   -- Thermomechanical Properties

Figure 1.

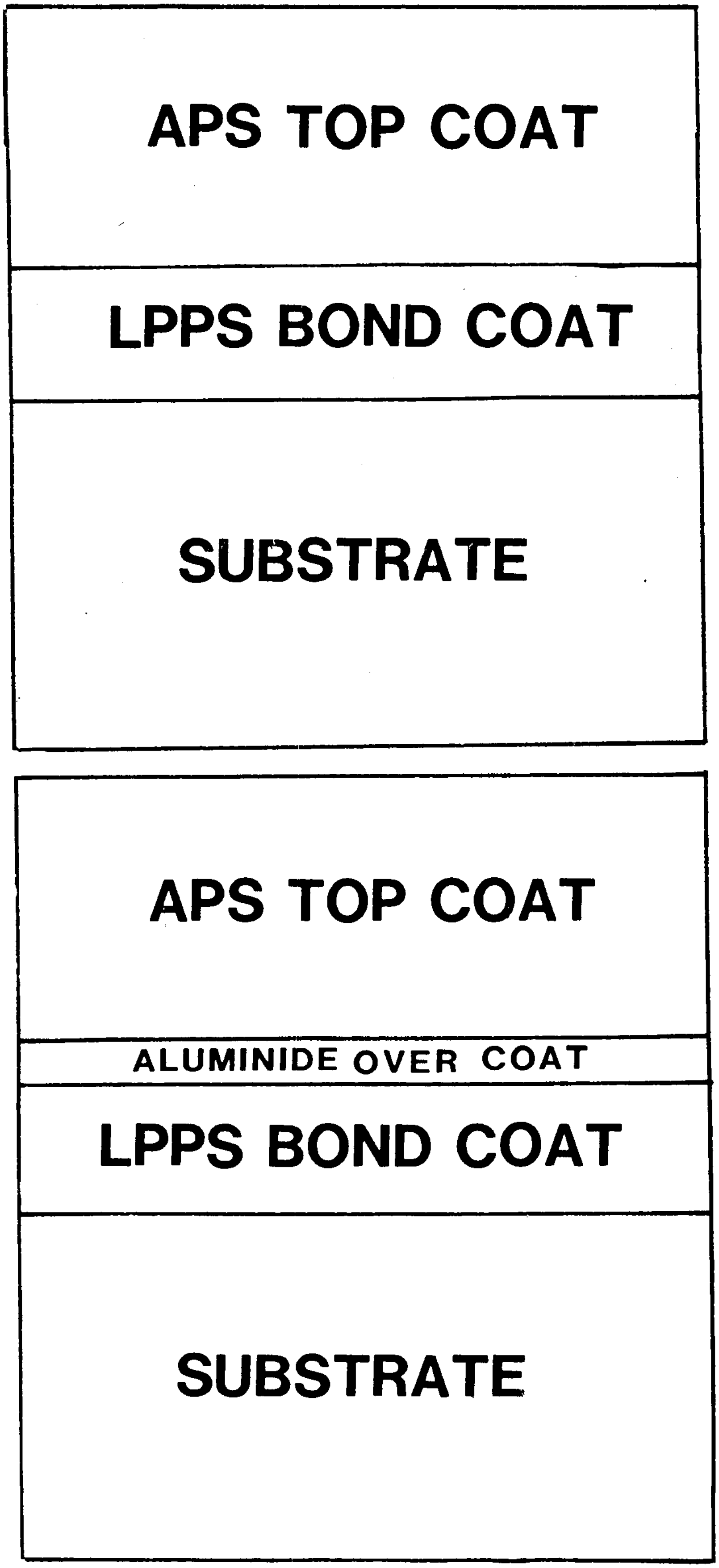
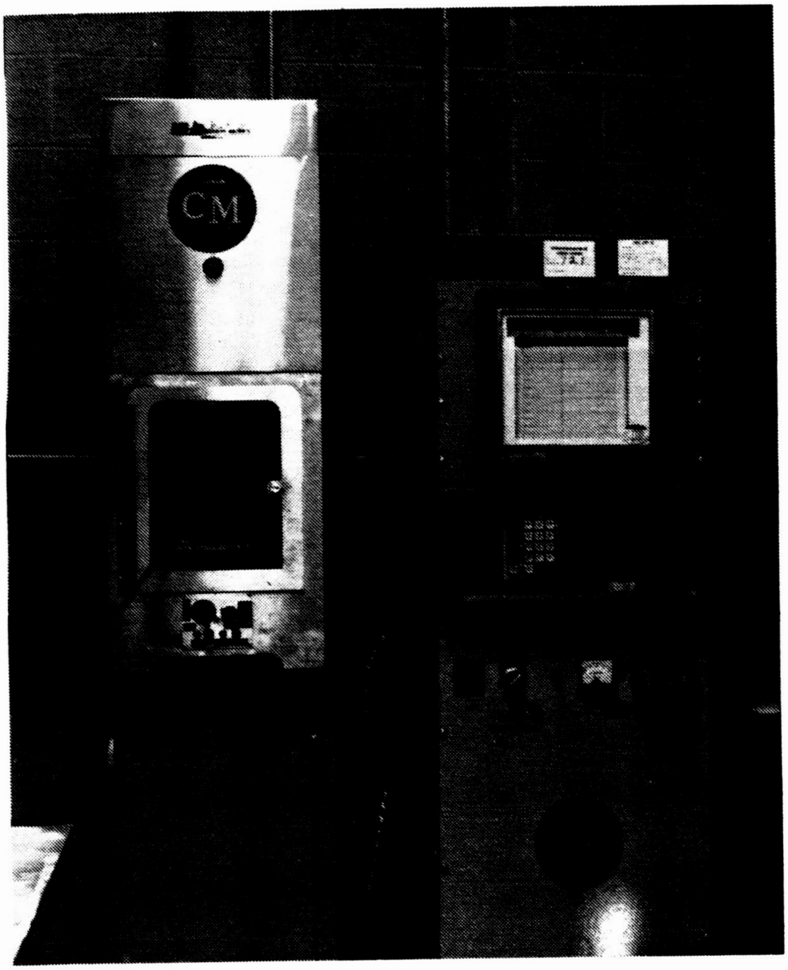

APS TOP COAT
LPPS BOND COAT
SUBSTRATE
APS TOP COAT
ALUMINIDE OVER COAT
LPPS BOND COAT
SUBSTRATE

Figure 2.



RAPID TEMPERATURE FURNACE

--- 10 minute heat up

--- 45 minute exposure at 2000 F

--- 15 minute forced cooling

Figure 3.

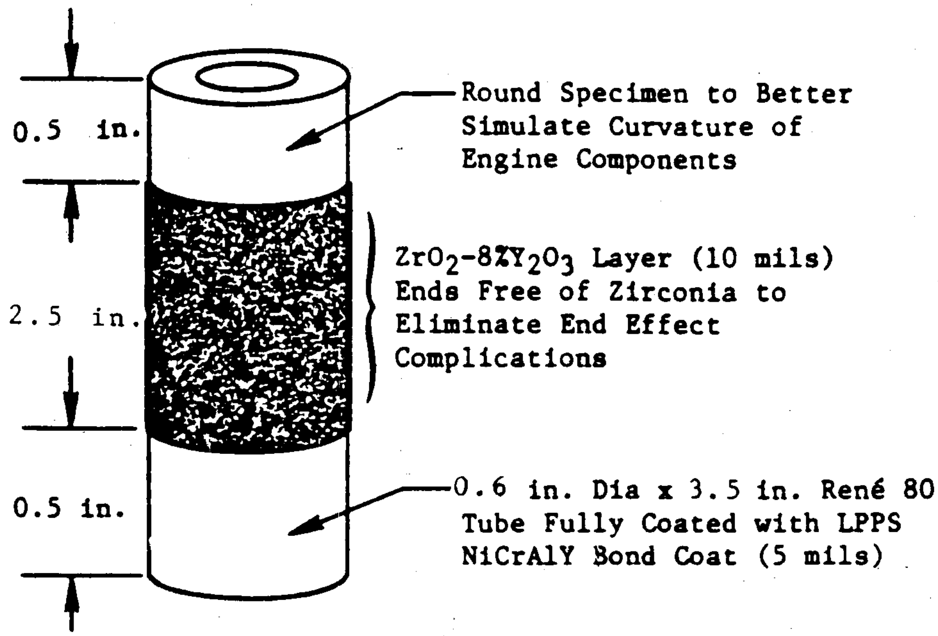
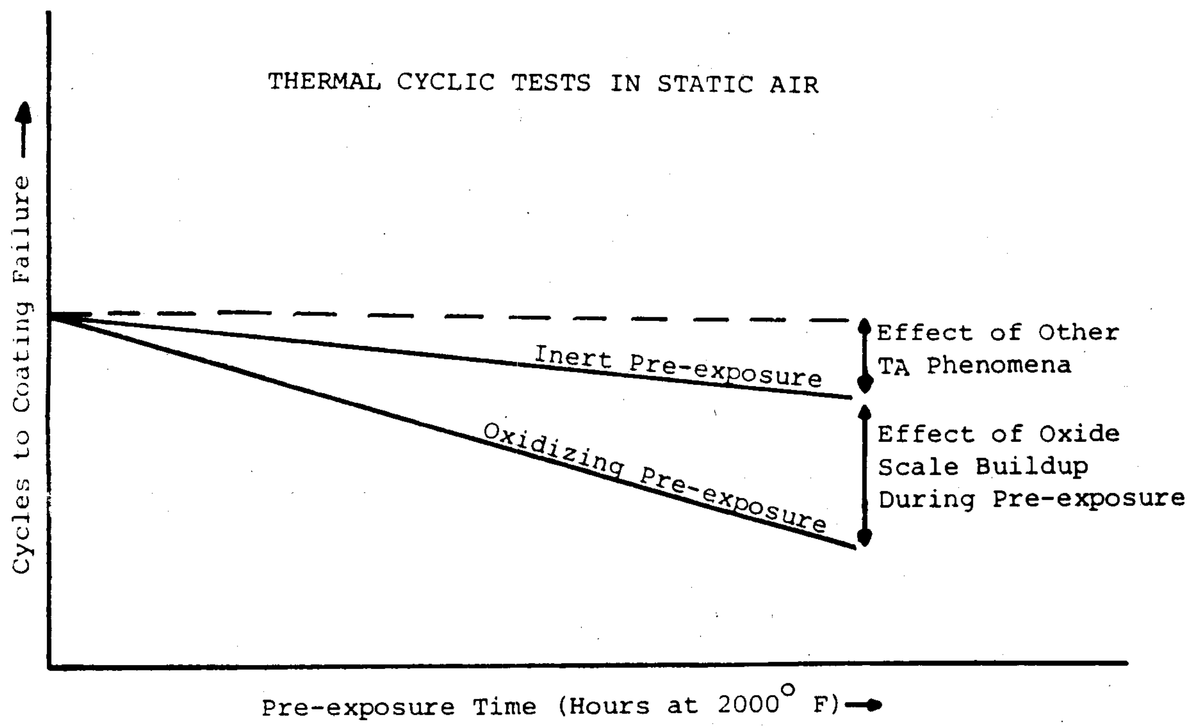


Figure 4.



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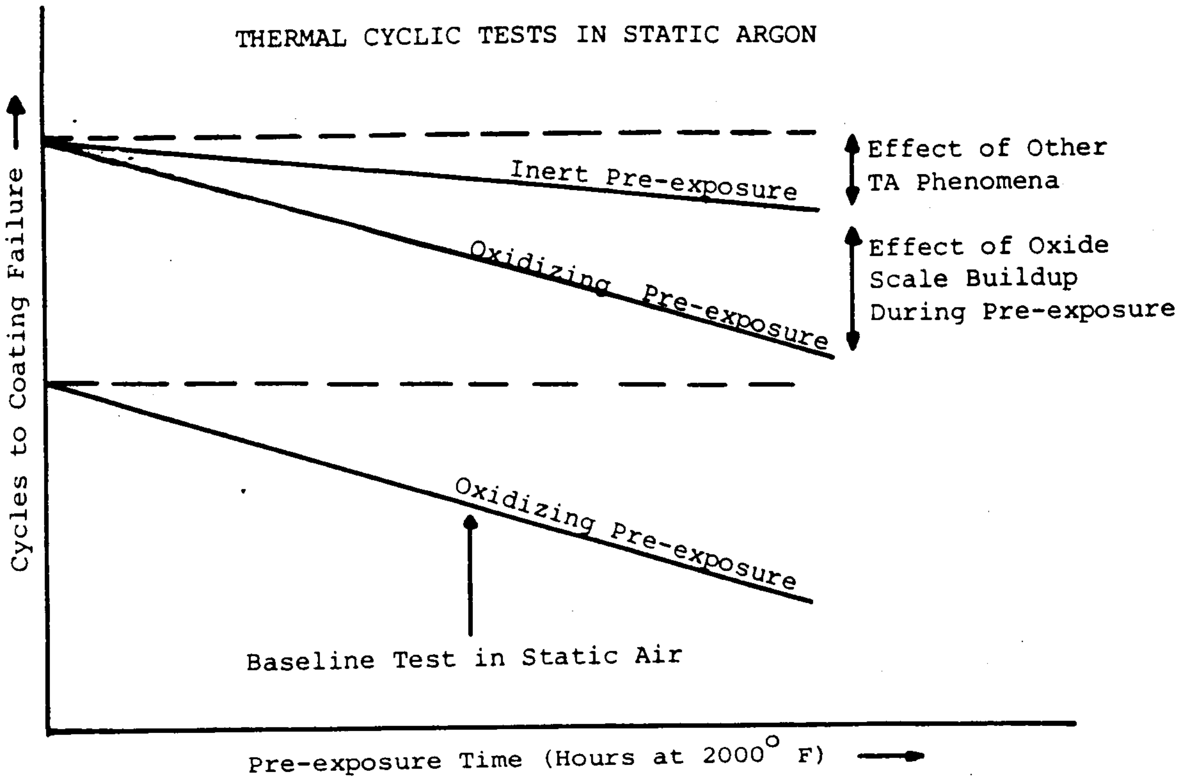

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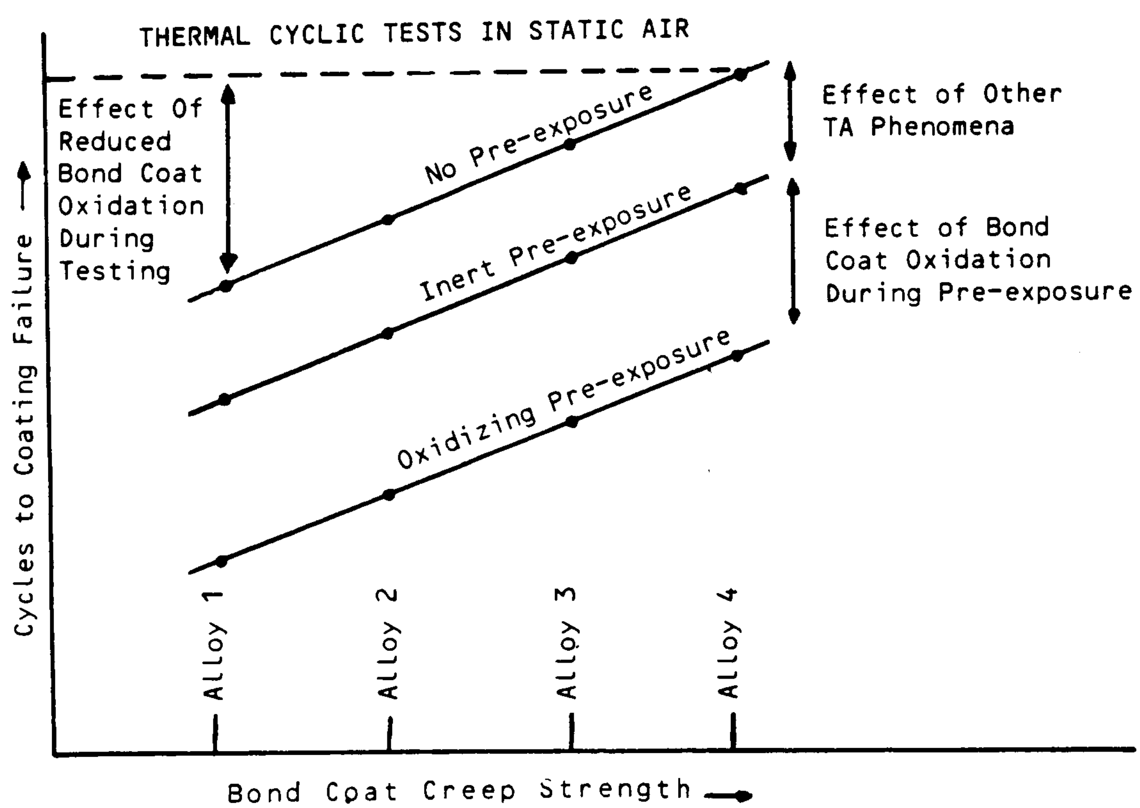

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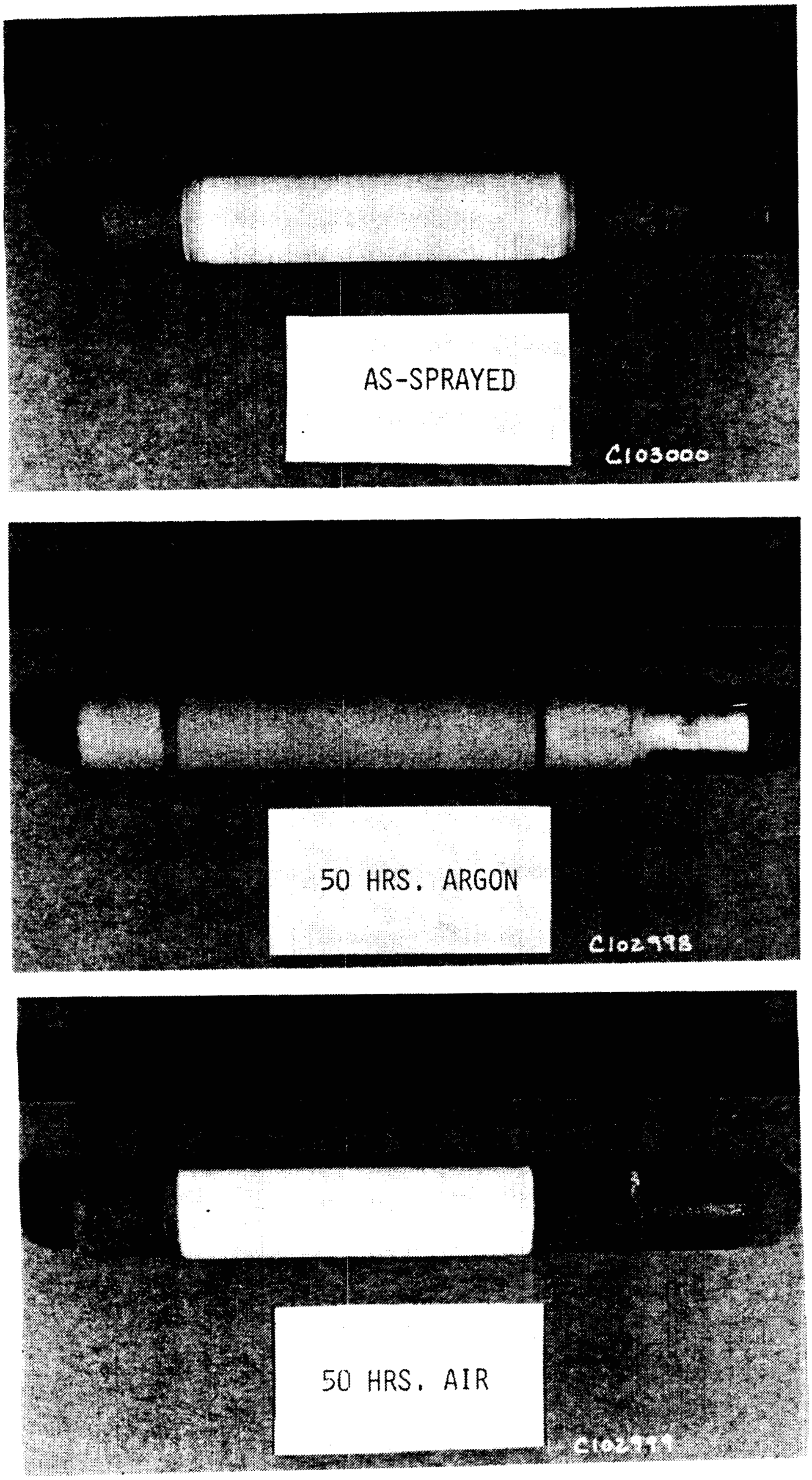

Figure 8.

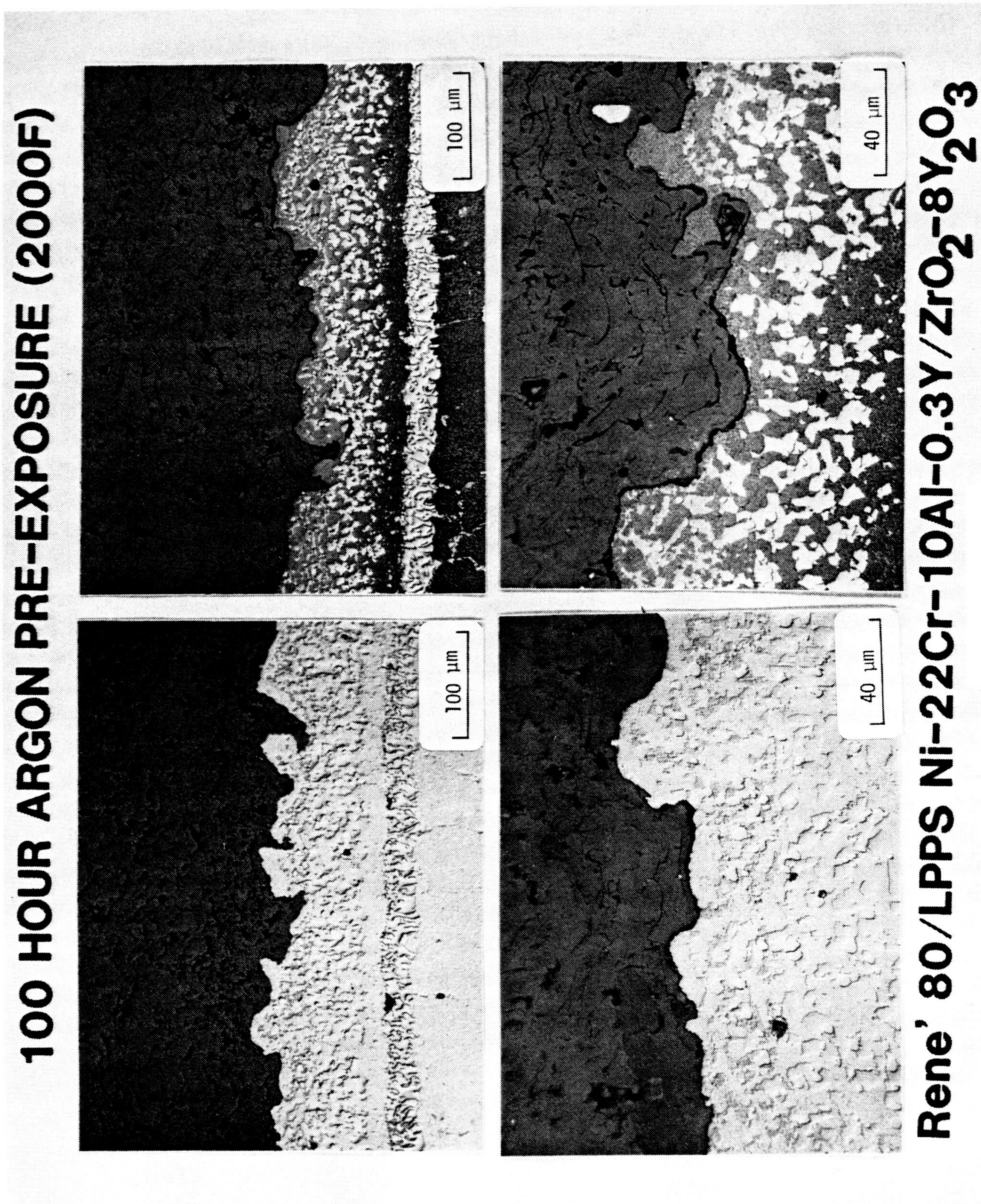

Figure 9.

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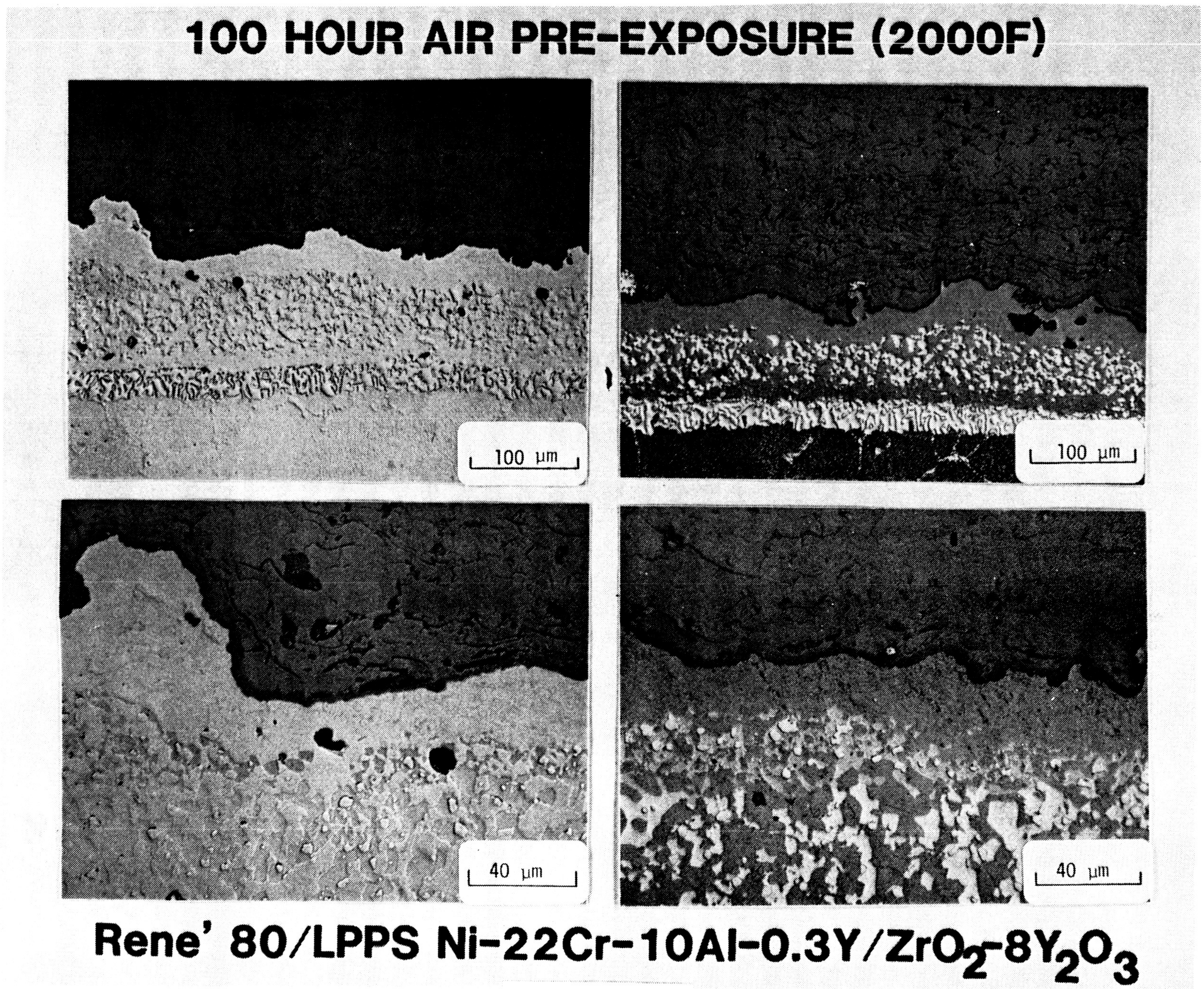
100 HOUR AIR PRE-EXPOSURE (2000F)
100 μm
100 μm
40 μm
40 μm
Rene' 80/LPPS Ni-22Cr-10Al-0.3Y/ZrO_2-8Y_2O_3

Figure 10.

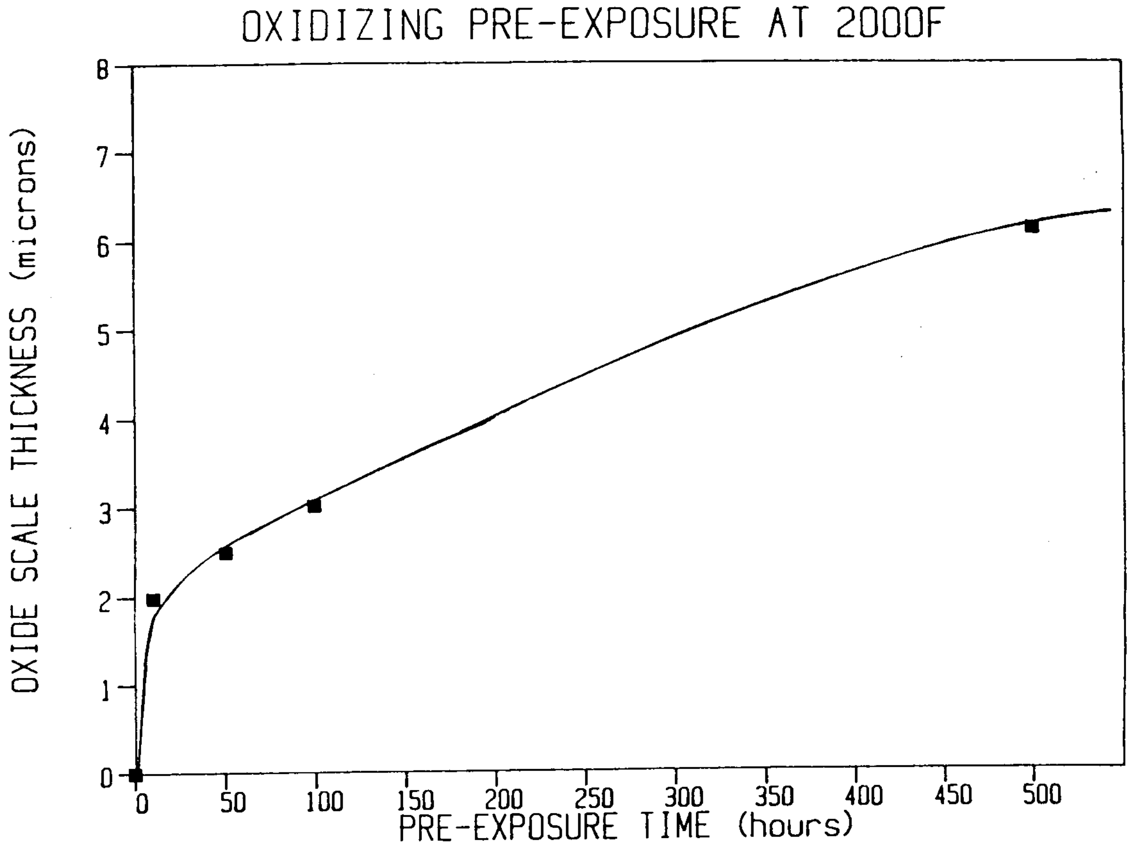

Figure 11.

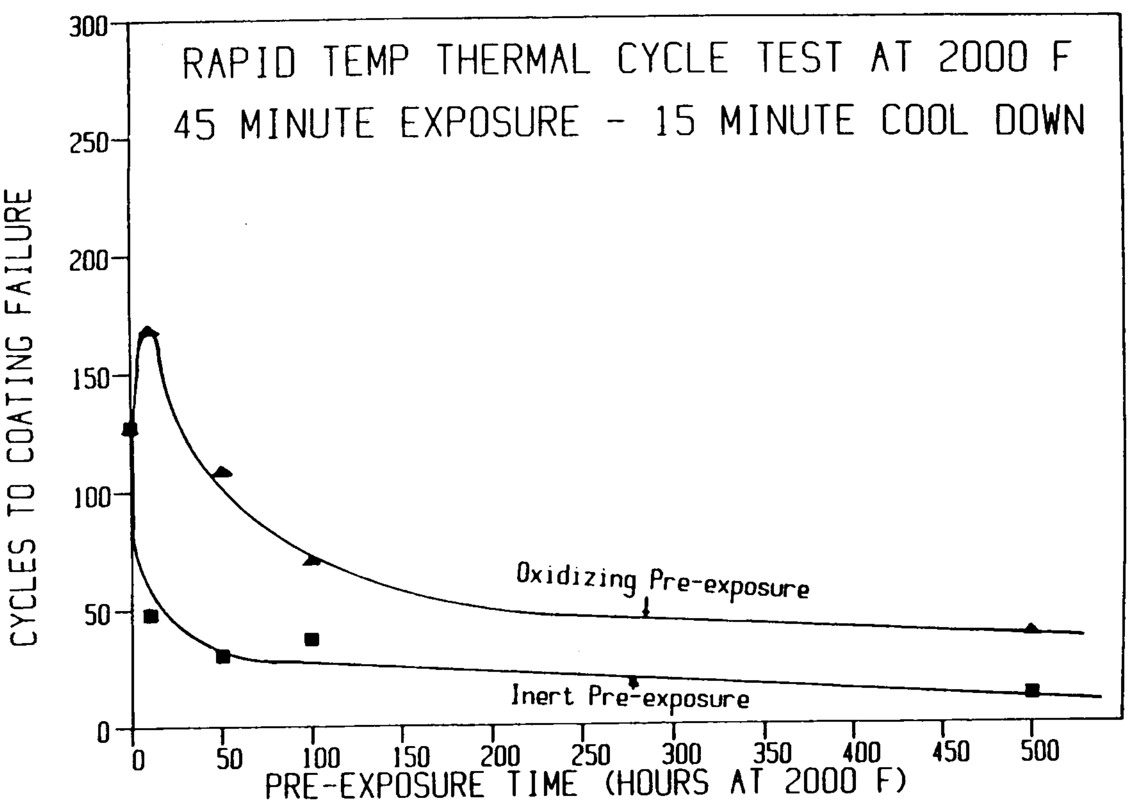

Figure 12.