N89-13657

5/5-27
181383
4P.

ALUMINUM OXIDE BARRIERS IN MCrAlY SUPERALLOY SYSTEMS

Kenneth G. Kreider
National Bureau of Standards
Gaithersburg, Maryland 20899

An investigation was made of sputtered aluminum oxide diffusion barriers to protect gas turbine engine blade and vane alloys from their coatings. MAR M200 + Hf coated with sputtered NiCoCrAlY and MAR M509 coated with sputtered FeCrAlY were obtained both with and without 1 μm and 2 μm sputtered Al_2O_3 barrier layers. Electron dispersive X-ray analysis was used to determine the concentration profiles of as-received and heat treated samples.

The Al map of a MAR M200 + Hf sample with a NiCoCrAlY coating and a 1 μm barrier after a 1080°C, 50 hour heat treatment in air is presented in Fig. 1. The diffusion profiles of a sample heat treated under the same conditions without the barrier is given in Fig. 2. A gradual transition from the coating (46% Ni, 23% Co, 18% Cr, 12% Al, 0.5% Y) to the base alloy (70% Ni, 10% Co, 9% Cr, 5% Al plus Ti, Hf, Cb, B, C) is observed across the interface which is 80 μm from the surface. Aluminum depletion due to oxidation is observed at the surface. Figure 3 shows the profiles with a 1 μm barrier. The interdiffusion of Ni, Co, Cr, and Al appear similar.

A clearer indication of the penetration through the barrier layer is presented in Figs. 4 and 5 which show the diffusion profiles for samples with MAR M509 (54% Co, 24% Cr, 10% Ni plus W, Ta, Ti, Zr, and C) and coating (70% Fe, 18% Cr, 11% Al, 0.7% Y). The iron and aluminum are penetrating up to 60 μm into the base alloy. The coating problem is illustrated in Fig. 6 where metallic bridges seem to cross the Al_2O_3 barrier. Apparently, the sputtered alumina is cracking in tension during heating which leads to interdiffusion of Fe, Al, and Co.

PRECEDING PAGE BLANK NOT FILMED

PAGE 166 INTENTIONALLY BLANK

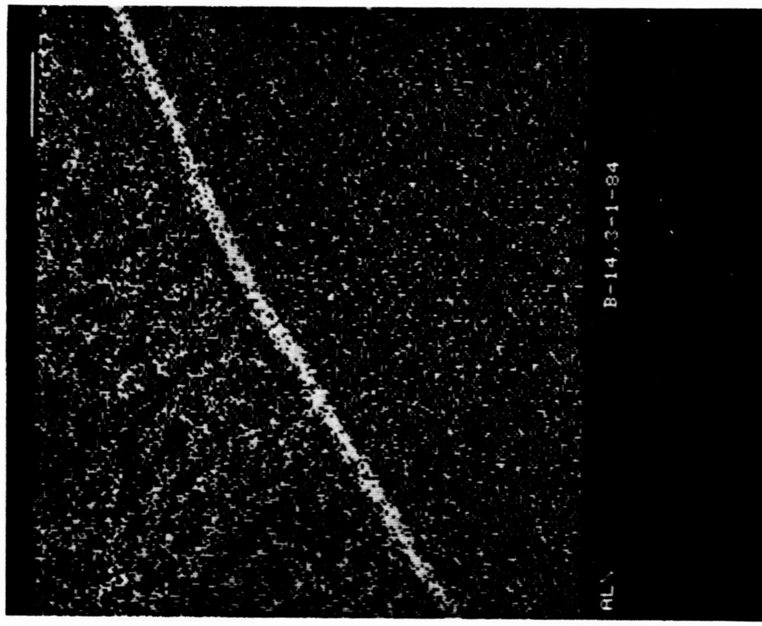

Figure 1. - Al map of D14 (580x). Heat treated at 1080 °C for 50 hr.

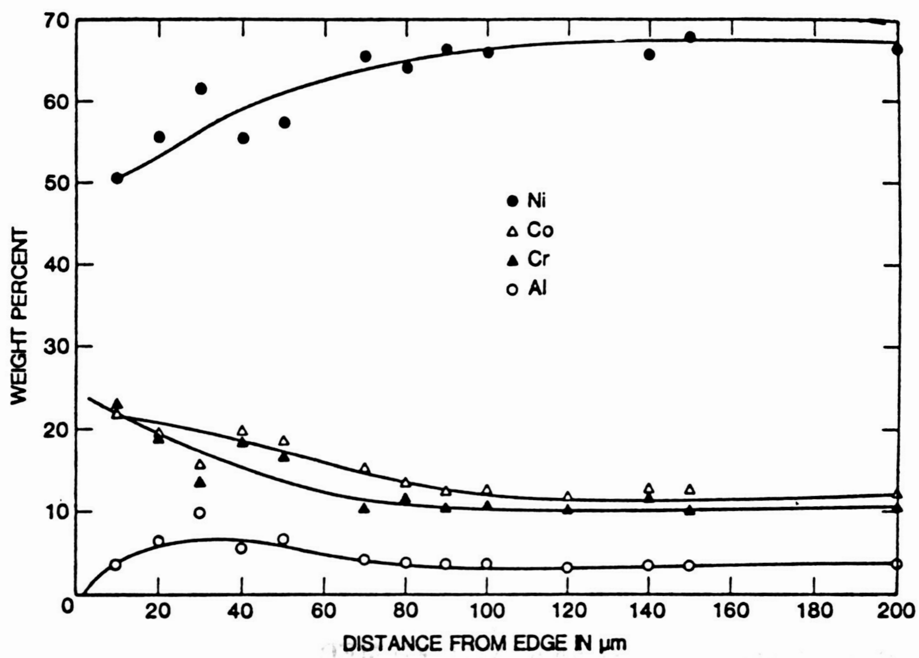

Figure 2. - Diffusion profiles of D4. Heat treated at 1090 °C for 50 hr without barrier.

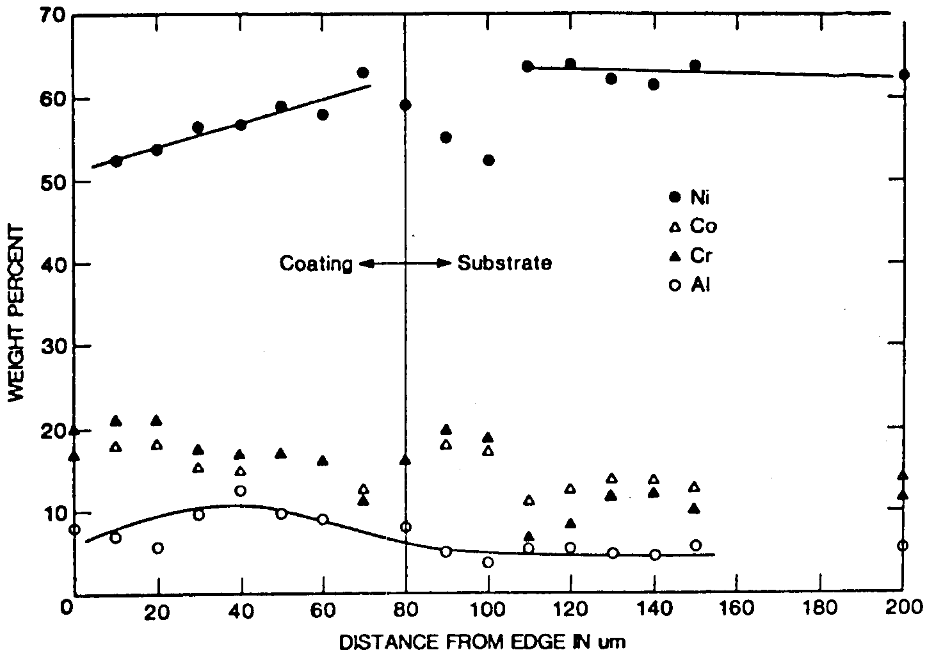

Figure 3. - Diffusion profiles of D14. 1-μm barrier layer, 1080 °C, 50 hr.

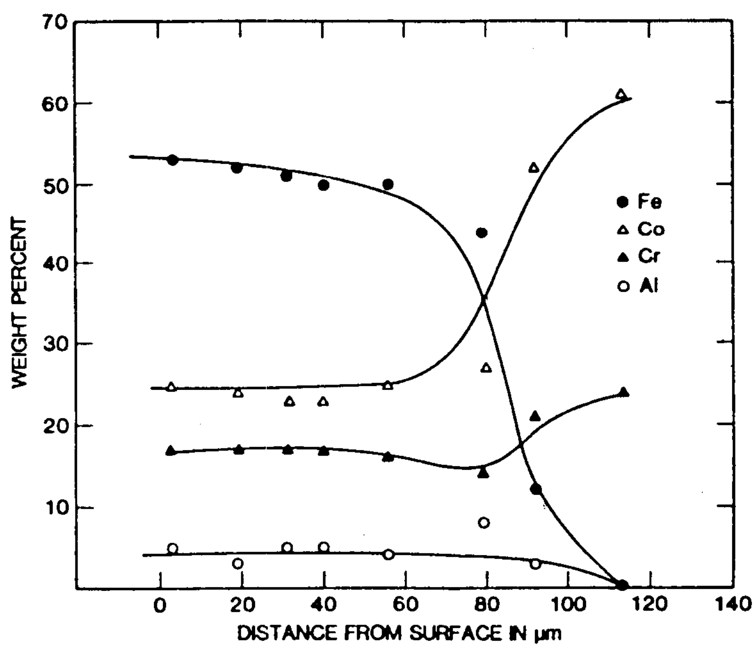

Figure 4. - Diffusion profiles of A40. No barrier layer, 1075 °C, 50 hr.

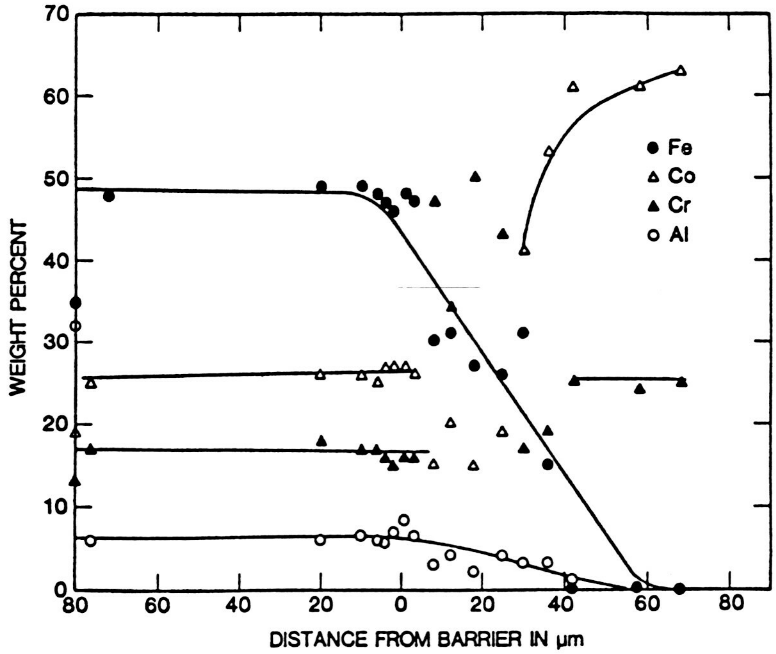

Figure 5. - Diffusion profiles of A19. 2-μm barrier, 1075 °C, 86 hr.

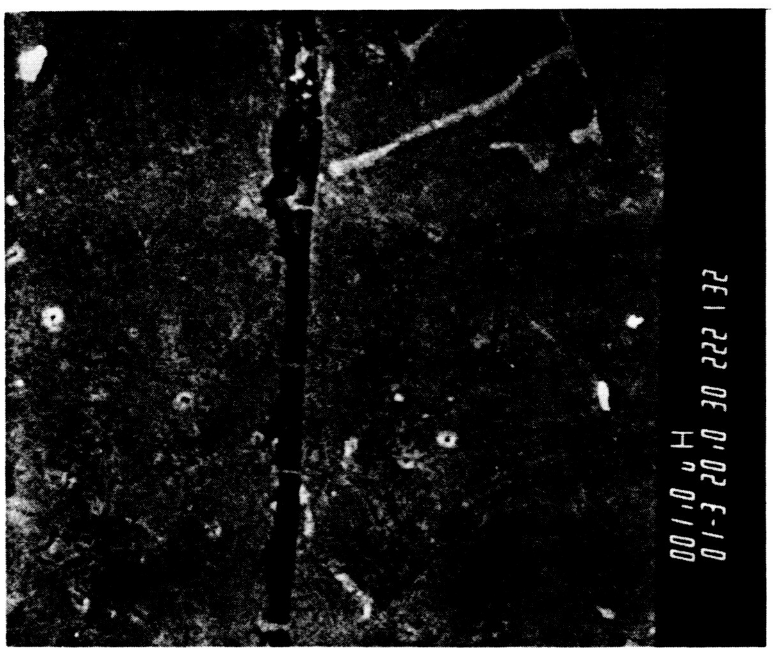

Figure 6. - Scanning electron micrograph of A19. Note bridging of Al_2O_3 barrier layer with metal.