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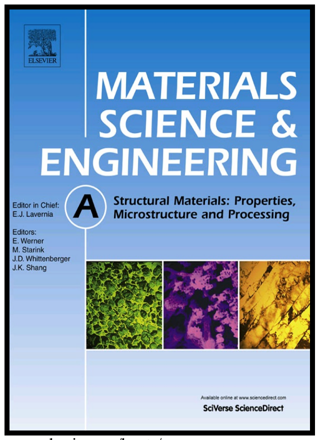

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Microstructural and Creep Properties of Boron- and Zirconium-Containing Cobalt-based Superalloys

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Abstract

The effects of micro-additions of boron and zirconium on grain-boundary (GB) structure and strength in polycrystalline γ(f.c.c.) plus γ'($L1_2$) strengthened Co-9.5Al-7.5W-X at. % alloys (X = 0-Ternary, 0.05B, 0.01B, 0.05Zr, and 0.005B-0.05Zr at. %) are studied. Creep tests performed at 850 ºC demonstrate that GB strength and cohesion limit the creep resistance and ductility of the ternary B- and Zr-free alloy due to intergranular fracture. Alloys with 0.05B and 0.005B-0.05Zr both exhibit improved creep strength due to enhanced GB cohesion, compared to the baseline ternary Co-9.5Al-7.5W alloy, but alloys containing 0.01B or 0.05Zr additions display no benefit. Atom-probe tomography (APT) is utilized to measure GB segregation, where B and Zr are demonstrated to segregate at GBs. A Gibbsian interfacial excess of 5.57 ± 1.04 atoms nm^{-2} was found for B at a GB in the 0.01B alloy and 2.88 ± 0.81 and 2.40 ± 0.84 atoms nm^{-2} for B and Zr, respectively, for the 0.005B-0.05Zr alloy. The GBs in the highest B-containing (0.05B) alloy exhibit micrometer-sized boride precipitates with adjacent precipitate denuded-zones (PDZs), whereas secondary precipitation at the GBs is absent in the other four alloys. The 0.05B alloy has the smallest room temperature yield strength, by 6 %, which is attributed to the PDZs, but it