THE EFFECTS OF ALLOYING ADDITIONS IN POLYCRYSTALLINE CO-NI SUPERALLOYS

Paul Mulvey, Imperial College London
p.mulvey13@imperial.ac.uk
David Dye, Imperial College London
Mark Hardy, Rolls Royce Plc

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New Co-Ni superalloys are being considered as a potential replacement for current Ni superalloys used in gas turbine applications. Utilizing the stable $L1_2$ phase $Co_3(Al,W)$ discovered in 2006[1] M.Knop et al. developed the new γ/γ' polycrystalline superalloy V208C, which exhibited favourable strength and oxidation performance when compared to existing Ni and Co superalloys[2]. Further work has now been done to evolve the alloy chemistry of V208C in order to make a step towards the next iteration of a potential candidate alloy. Using the nominal composition of V208C, 36Co-35Ni-15Cr-10Al-3W-1Ta-0.15C-0.2B-0.04Zr (at%), further additions of 1Cr, 1Al, 1Mo, 2Mo, 0.5Nb and a swap of the C/B content were investigated using a laboratory-scale cast and wrought process to produce a series of ingots for characterization. Differential scanning calorimetry (DSC) was used to determine the γ' solvus temperatures of each alloy, with the 1Al addition providing the most significant increase from 1000°C to 1020°C. The oxidation performance of each alloy at 800°C for 100 hours was examined via a combination of thermogravimetric analysis (TGA) and focused ion beam (FIB) cross-sectioning of the oxide layers. The 1Al addition, again, exhibited the best oxidation performance, with the 1Mo addition also performing well. High-temperature tensile testing determined the yield strength of each specimen at room temperature and at 50°C intervals from 650-900°C. The alloys all displayed the flow stress anomaly; with 2Mo possessing the highest yield stress at room temperature and 1Al at the high-temperature peak. The γ' fraction, size and distribution were observed using electron microscopy, indicating that the addition of 1Al caused the most significant rise in γ' fraction from 50% to 53%. Special consideration was given to the C/B content swap in order to understand how it may effect the mechanisms of grain boundary precipitate formation, as well as the subsequent impact on strength performance.

References:

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