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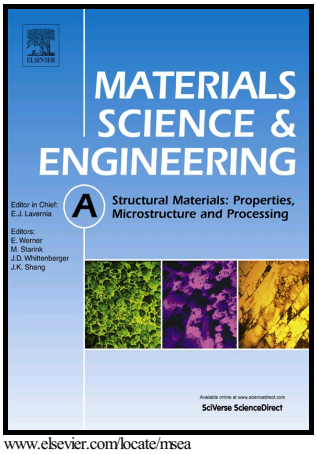

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Microstructure and mechanical properties of two Z-phase strengthened 12%Cr martensitic steels: the effects of Cu and C

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Abstract

Z-phase strengthened 12% Cr steels are designed to combine good corrosion and creep resistance for applications in fossil fuel power plants with steam temperatures up to 650°C. Two trial Z-phase strengthened steels were investigated, Z-steel with ultra-low C content, and ZCuC-steel with relatively high C content and Cu addition. The Z-steel has better creep strength; however, the alloy has low impact toughness due to the formation of continuous Laves-phase films at grain boundaries. Atom probe tomography, transmission electron microscopy, and scanning electron microscopy were employed to study the effects of C and Cu on the microstructure of the two steels in the as-tempered condition, and after ageing for different times. The Z-steel shows a fast transformation from TaN to Z-phase. The relatively high C content in the ZCuC-steel resulted in the formation of two categories of MX: Ta(C, N) and TaN. The phase transformation from Ta(C, N) to Z-phase is slower compared to that from TaN to Z-phase. In addition, precipitation of $M_{23}C_6$ and Cu particles in the ZCuC-steel led to easier nucleation of Laves-phase, and hence a much improved toughness.

Keywords: creep, impact toughness, electron microscopy, atom probe tomography, precipitation, Laves-phase