The 51st Annual Meeting of ISM
Weizmann Institute of Science, Rehovot

POSTER #27

DIFFERENCES IN MICROSTRUCTURAL EVOLUTION OF DENDRITE AND INTERDENDRITE AREAS IN Al-Co-Cr-Fe-Ni HIGH ENTROPY ALLOY

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High entropy alloys (HEA) contain at least five principal elements with a concentration of 5÷35at.%. yielding a solid solution with a simple crystallographic structure, namely bcc, fcc or hcp [1]. The alloys exhibit unique combinations of good mechanical properties, high temperature durability, wear and oxidation resistance. One of the most studied HEA alloys is AlCoCrFeNi which solidifies in a dendritic regime forming Al+Ni rich dendrite (DR) and Fe+Cr rich inter dendrite (ID) [1,2]. Both areas are composed of ordered bcc (B2) matrix and bcc particles but display significant differences in morphology and hardness [2]. The differences between the DR and ID regions are also manifested in the evolution of the microstructure upon heat treatments. Up to date no explanation to these differences was provided. This question was addresses in the current study by combining several methods of transmission electron microscopy (TEM).

TEM analysis revealed that the matrix of the DR area constitutes of nano-sized domains with long period boundaries. We believe that these domains arrest the growth of the bcc particles keeping their size small and their shape cuboidal. In the ID area - short range order in B2 (manifested by diffuse scattering in the electron diffraction pattern) was observed. In this region, bcc particles grew along specific crystallographic plains yielding the characteristic Γ and T shape morphologies.

Heat treatment at 850℃ caused the anticipated phase transformation to fcc and σ (CrFe structure type) only in the ID regions while DR remained essentially unchanged although some coarsening of the bcc particles occurred and seldom fcc particles grew in the B2 matrix. We believe that in the DR region the bcc to σ transformation was arrested by the high strains associated with this transformation that could not be accommodated along the boundaries with the domain structured B2 matrix. Heat treatment at 1200℃ yields finer morphologies of the two predominant phases, bcc and B2. The extent of homogenization increases with dwelling time as reminiscences of the dendritic morphology are eliminated.

References:

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