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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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DENDRITE ORIENTATION SELECTION IN MAGNESIUM-BASED ALLOYS

Abstract

Final microstructure of cast alloys is often set by the dendritic morphology established during solidification, specifically in emerging technologies such as twin belt casting where little thermomechanical post-processing is applied. Mechanical properties of the alloy are then closely correlated to the established dendritic microstructure. While the solidified microstructure and its effects on the materials properties have been the subject of intensive studies little is known about the fundamental mechanisms that determine the microstructure and its evolution under directional growth conditions. Mg-based alloys are gaining more demands for weight reduction in the transportation industry on account for their high strength to weight ratio, which accordingly reduces the gas consumption. We study the directional solidification of magnesium-aluminum alloys both experimentally and computationally utilizing phase field method. The hexagonal crystal structure of magnesium-based alloys introduces a six-fold morphological symmetry, which leads to a competition between temperature gradient and surface energy anisotropy directions and remarkably influences the resulting microstructure. We find that three general types of microstructure form as cooling rate and anisotropy strength vary. Particularly, at high anisotropy strength and low cooling rates, primary stalks cross at 60-degree angles that characterize the hexagonal crystal structure. As cooling rate increases, seaweed and columnar dendrites develop. Our results compare well with Haxhimali's work wherein the competition between the first two cubic harmonics that characterize the surface energy anisotropy leads to the formation of various dendritic structures.