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Modeling and simulation of dendrite and porosity evolution during solidification in the molten pool of Al–Cu alloys

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ABSTRACT

The dendrite and porosity evolution during solidification in the molten pool of Al-3wt% Cu alloy is simulated in this paper. The growth of dendrite and hydrogen gas pore is reproduced using a cellular automaton (CA) approach. And the diffusion of solute and hydrogen is calculated using the finite difference (FD) method. The model is applied to simulate the formation and interactions of dendrites and pores in an Al-3wt% Cu alloy. The effects of initial hydrogen concentration and cooling rate on porosity evolution are investigated. It is found that with the increase of initial hydrogen concentration, the percentage of porosity increases, while porosity density does not increase. With the decrease of cooling rate, the percentage of porosity increases, but the porosity density displays a decreasing trend. The competitive growth between dendrites and porosities is also observed. The competitive growth between dendrites and porosities becomes more evident, leading to a more non-uniform distribution of porosity size, and an increased maximum porosity size at a slower cooling rate. The simulation results show well agreement with experiments.

KEYWORDS: numerical simulation, dendrite growth, hydrogen porosity evolution, solute diffusion