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Original Article

Multiphase aluminum A356 foam formation process simulation using lattice Boltzmann method

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ABSTRACT

Shan–Chen model is a numerical scheme to simulate multiphase fluid flows using lattice Boltzmann approach. The original Shan–Chen model suffers from inability to accurately predict behavior of air bubbles interacting in a non-aqueous fluid. In the present study, we extended the Shan–Chen model to take the effect of the attraction–repulsion barriers among bubbles in to account. The proposed model corrects the interaction and coalescence criterion of the original Shan–Chen scheme in order to have a more accurate simulation of bubbles morphology in a metal foam. The model is based on forming a thin film (narrow channel) between merging bubbles during growth. Rupturing of the film occurs when an oscillation in velocity and pressure arises inside the channel followed by merging of the bubbles. Comparing numerical results obtained from proposed model with metallography images for aluminum A356 demonstrated a good consistency in mean bubble size and bubbles distribution.

1. Introduction

Demanding for advanced materials are increasing rapidly via new technologies. Closed cell metal foams gained a lot of interest as one of the major branches of advanced materials due to their unique physical and mechanical properties, including high specific strength and compressibility along with good energy absorption capability [1–4]. Despite the advantages, the employment of metal foams in industrial applications is limited due to the inhomogeneity of the structure which results in the deviation of the mechanical properties of the foams from what predicted by the scaling relations. This is mainly due to the morphological defects such as missing or wavy distortions of the cell walls and non-uniform shape and size of the cells which results in poor reproducibility of foam structures [5]. In metals, unlike ionic liquids, the formation mechanism of metal foam has not yet fully understood [5].

Bubble stability is the primitive challenge in understanding the mechanism of metal foam formation. A variety of studies and researches have been performed by scientists in order to investigate and analyze the parameters affecting bubble stabilization [4–14]. Most of the investigations have focused on formation of single bubble in ionic liquid environment,

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