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Fabrication of porous materials

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The shape of a pore, resulting from a bubble entrapped by a solidification front, is predicted in this work. Porosity influences not only microstructure of materials, but also contemporary issues of various sciences of biology, engineering, foods, geophysics and climate change, etc. In this presentation, pore shape is determined by accounting for mass and momentum transport of solute across a self-consistent shape of the cap, as proposed previously. This work finds that there exist three different mechanisms for pore formation, depending on different directions and magnitude of solute transfer across the cap. Case 1 is subject to solute transport from the pore into surrounding liquid as a result of the cap emerged from a thin concentration boundary layer on the solidification front in the early stage. An increase in initial solute concentration in liquid decreases pore radius and times for bubble entrapment. Opposite directions of solute transport across the cap submerged into a thick concentration boundary layer along the solidification front, however, cannot result in bubble entrapment, because solute increases and decreases rapidly in late stage in Cases 2 and 3, respectively. The predicted pore shape in solid agrees with experimental data. Numerical computations of development of the pore shape associated with transport processes of fluid flow, temperature and concentration are also presented in Fig. 1.

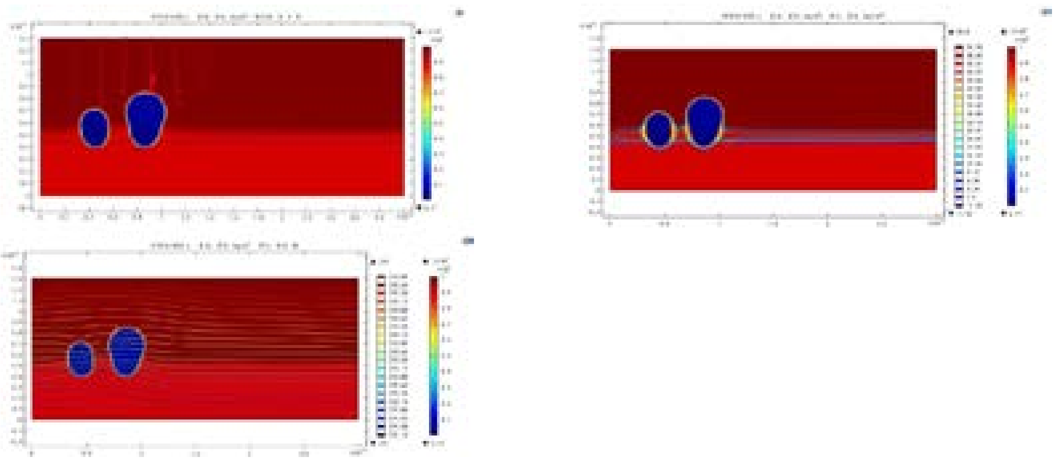

Fig. 1 Predicted pore shape, and distributions of velocity, temperature and solute concentration fields of two pores at a time of 0.0102 s in Case 1.

Recent publications

1. Wei P S and Chao T C (2016) The effects of drilling parameters on pore size in keyhole mode welding. ASME Journal of Manufacturing Science and Engineering 138:021008.
2. Wei P S and Chang C C (2016) Existence of universal phase diagrams for describing general pore shape resulting from an entrapped bubble during solidification. ASME Journal of Heat Transfer 138:104503.
3. Wei P S and Hsiao S Y (2016) Effects of mass transfer coefficient on pore shape in solid. International Journal of Heat and Mass Transfer 103: 931-939.
4. Wei P S and Hsiao S Y (2016) Effects of solute concentration in liquid on pore shape in solid. International Journal of Heat and Mass Transfer 103: 920-930.
5. Hsiao S Y and Wei P S (2016) Case study of terrestrial or ambient pressure effects on pore shape in solid. AIAA Journal of Thermophysics and Heat Transfer 31(4):796-804.

Biography

Peng-Sheng Wei has received his PhD in Mechanical Engineering Department at University of California, Davis, in 1984. He has been a Professor in the Department of Mechanical and Electro-Mechanical Engineering of National Sun Yat-Sen University, Kaohsiung, Taiwan, since 1989. He has contributed to advancing the understanding of and to the applications of electron and laser beam, plasma, and resistance welding through theoretical analyses coupled with verification experiments. Investigations also include studies of their thermal and fluid flow processes, and formations of the defects such as humping, rippling, spiking and porosity. He has published more than 80 journal papers, given keynote or invited speeches in international conferences more than 90 times. He is a Fellow of AWS (2007), and a Fellow of ASME (2000). He also received the Outstanding Research Achievement Awards from both the National Science Council (2004), and NSYSU (1991, 2001, and 2004), Outstanding Scholar Research Project Winner Award from National Science Council (2008), Adams Memorial Membership Award from AWS (2008), Warren F Savage Memorial Award from AWS (2012), and the William Irrgang Memorial Award from AWS (2014). He has been the Xi-Wan Chair Professor of NSYSU since 2009, and Invited as Distinguished Professor in the Beijing University of Technology, China, during 2015-2017.

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