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Porosity encountered in welding processes

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This lecture analyzes different types of porosity formation in low and high- power-density-beam welding processes. Porosity is susceptible to stress concentration, degrading properties of products in welding, manufacturing and materials technologies. Pore formation can be due to either a bubble entrapment or keyhole collapse during solidification. Pore formation due to a bubble entrapment can be analyzed by proposing a model accounting for species and momentum transport and physicochemical equilibrium at the cap. This work finds that there exist three different cases for pore formation, depending on solidification rate and directions and magnitude of solute transfer across the cap. Case 1 subject to solute transport from the pore into surrounding liquid in the early stage is susceptible to bubble entrapment for a high solidification rate. Pore formation due to keyhole collapse can be studied by proposing a model for a compressible flow through a keyhole of varying cross-section and its transition from annular to slug flows. Introducing the Young-Laplace equation, pore radius due to keyhole collapse decreases as absorbed energy in the keyhole increases. The predicted pore shapes in solid in low and high-power-density-beam welding agree with experimental data.

Biography

Dr. Peng-Sheng Wei received Ph.D. 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. Dr. Wei 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. Dr. Wei has published more than 80 SCI journal papers, given keynote or invited speeches in international conferences more than 120 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, 2004), the Outstanding Scholar Research Project Winner Award from National Science Council (2008), the Adams Memorial Membership Award from AWS (2008), the 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 Distinguished Professor in the Beijing University of Technology, China, during 2015-2017.

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