Abstract

Mahmoud A. El-Sayed

The behaviour of bifilm defects in cast Al-7Si-Mg alloy

Double oxide films (bifilms) are significant defects in the casting of light alloys, and have been shown to decrease tensile and fatigue properties, and also to increase their scatter, making casting properties unreproducible and unreliable. A bifilm consists of doubled-over oxide films containing a gas-filled crevice and is formed due to surface turbulence of the liquid metal during handling and/or pouring. Previous studies has shown that the nature of oxide film defects may change with time, as the atmosphere inside the bifilm could be consumed by reaction with the surrounding melt, which may enhance the mechanical properties of Al alloy castings. As a proxy for a bifilm, an air bubble was trapped within an Al-7wt.%Si-0.3wt.%Mg (2L99) alloy melt, subjected to stirring. The effect of different parameters such as the holding time, stirring velocity and melt temperature on the change in gas composition of the bubble was investigated, using a design of experiments (DoE) approach. Also, the solid species inside the bubbles solidified in the melt were examined using SEM. The results suggested that both oxygen and nitrogen inside the bifilm would be consumed by reaction with the surrounding melt producing $MgAl_2O_4$ and AlN, respectively. Also, hydrogen was suggested to consistently diffuse into the defect. The reaction rates and the rate of H diffusion were shown to increase upon increasing the holding time and temperature, and stirring velocity. Such significant effect of the process parameters studied on the gaseous content of the bubble suggesting that a careful control of such parameters might lead to the deactivation of bifilm defects, at least elimination of their deteriorous effect in light alloy castings.