Abstract

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Determination of the Lifetime of a Double-Oxide Film in Al Castings

One of the most important casting defects in Al alloys is thought to be the double-oxide film defect (bifilm) which has been reported to have a rious effect on the reproducibility of the mechanical properties of Al castings. Previous research has suggested that the atmosphere inside such bifilms could be consumed by reaction with the surrounding melt, which might decrease the size of the defects and reduce their harmful effect on mechanical properties. In order to follow the change in the composition of the interior atmosphere of a bifilm, analog air bubbles were held inside Al alloy melts, for varying lengths of time, and subjected to stirring, followed by solidification. The bubble contents were then analyzed using a mass spectrometer to determine the changes in their compositions with time. The results suggested that initially oxygen and then nitrogen inside the bubble were consumed, and hydrogen dissolved in the melt diffused into the bubble. The consumption rates of O and N as well as the rate of H diffusion were dependent upon the type of oxide, which was dependent on the alloy composition. The reaction rates were the fastest with MgO (in an Al-5Mg alloy), slower with alumina (in commercial-purity Al alloy), and the slowest with $MgAl_2O_4$ spinel (in an Al-7Si-0.3Mg alloy). It was estimated that the times required for typical bifilm defects in the different alloys to lose their entire oxygen and nitrogen contents were about 345 seconds (~6 minutes), in the case of Al-5Mg 538 seconds (~9 minutes), in the case of a commercial purity alloy and 1509 seconds (~25 minutes), in the case of the Al- 7Si-0.3Mg alloy (2L99) due to the different oxides that the different alloys would be expected to form.