Abstract

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An Investigation into Double Oxide Film Defects in Aluminium Alloys

When the oxidised surface of a liquid metal is folded over onto itself and entrained double oxide film defects are formed, which form crevices cracks in the solidified casting, of varying sizes and orientations. These defects not only reduce mechanical properties, but also increase the scatter of properties. This paper reports an analog experiment to study the behavior of the interior atmosphere of double oxide film defects in Al alloy melts of varying Mg content. Air bubbles were trapped in melts of liquid Al alloy which were then solidified after holding for varying periods of time. The composition of the bubbles was subsequently measured using mass spectroscopy. This showed the reaction of oxygen from the bubble atmosphere to form oxides, followed by the consumption of nitrogen to form AlN. Simultaneously, hydrogen from the melt diffused into the air bubble. The changes in composition were used to estimate the rate of change in composition of the interior atmosphere of a typical double oxide film defect of an estimated size. This suggested that double oxide film defects may quickly achieve an interior atmosphere that would consist of a mixture of mainly nitrogen and hydrogen, and that this atmosphere could exist for periods of time greater than the typical solidification times of light alloy castings. In other words, oxide film defects created during mould filling should persist into the solidified casting. In addition, SEM analysis of oxide film defects also suggested the presence of oxide whiskers, which seem to have formed during holding in the melt.