

Whisker Formation in Porosity in Al Alloys



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An examination of the fracture surfaces of tensile test bars from Al alloy castings held in the liquid state for up to 20 minutes revealed porosity which in some cases contained whisker-like features. Energy-dispersive X-ray analysis in a SEM suggested that these might be oxide whiskers forming in an oxide-related pore or double oxide film defect. Such entrainment defects (also known as bifilms) may entrap a small amount of the local atmosphere when they form and become incorporated into the liquid metal. This atmosphere may be predominantly air, which then subsequently reacts with the surrounding melt, firstly by reaction with oxygen and secondly by reaction with nitrogen. A CFD model of the heat distribution associated with the reactions between the interior atmosphere of a double oxide film defect and the surrounding liquid alloy suggested that highly localized increases in temperature, up to about 2000 K to 5000 K (1727 LC to 4727 LC), could occur, over a scale of a few hundred micrometers. Such localized increases in temperature might lead to the evaporation or disassociation of oxide within the pore, followed by condensation, to form the whisker structures observed. Hydrogen might also be expected to diffuse into the bifilm and may play a role in the chemical reactions associated with the development of the bifilm.

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