Abstract

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X-ray microtomographic characterisation of pore evolution during homogenisation and rolling of Al-6Mg

The effect of homogenisation heat treatment and subsequent hot rolling on the evolution of porosity in a direct chill cast Al–6Mg (wt-%) alloy was studied. Porosity was quantified using conventional 2D optical metallography and X-ray microtomography (XMT) which allowed 3D imaging. Metallographic observations show an increase in maximum pore length during heat treatment and at the centre line during rolling. These observations together with the high temperatures might suggest a classical interpore Ostwald ripening mechanism is operative. However, XMT revealed that the pores have a highly tortuous shape, which when sectioned metallographically is not apparent and can lead to misinterpretation. X-ray microtomography observations proved that these tortuous 3D shapes spheroidised during homogenisation owing to localised coarsening of high curvatures within the complex, branching structure of each pore, termed intrapore coarsening. Accelerated centreline intrapore coarsening was observed during the initial rolling passes when relatively low reduction ratios were used. Finite element modelling was used to demonstrate that under the geometric rolling conditions employed the central region of the billet experienced a tensile rather than a compressive hydrostatic stress. This combined with deformation enhanced diffusion is proposed as the reason for the accelerated intrapore spheroidisation. X-ray microtomography was critical to revealing the true 3D pore shape and the mechanisms of pore coarsening, which could have been misinterpreted if only 2D metallography was used.