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Experimental study of the columnar-to-equiaxed transition during directional solidification of zinc-aluminum alloys and composites

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Abstract

The present study was undertaken to investigate the columnar-to-equiaxed transition (CET) in Zn-27wt%Al and Zn-50wt%Al alloys and composites with different compositions and with reinforcing particles of SiC and Al_2O_3. The CET was observed and related to the solidification thermal and structural parameters. The temperature gradient and the velocity of the liquidus front reach critical values at the CET. Also, the columnar length for composites increases respect to the Zn-Al alloys. The critical temperature gradient decreases when recalescence and velocity of the liquidus front increase. The presence of ceramic particles in the alloys affects the thermodynamic local conditions and the kinetic of nucleation producing a finer microstructure.

Key words: *Metal-matrix composites (MMCs), Columnar-to-equiaxed transition, Directional orientation, Thermal analysis*

1. Introduction

In general, equiaxial structures have bigger resistance, longer durability to fatigue, second phases more finely dispersed, better impact properties and workability. On the other hand, columnar structures commonly obtained in the production of turbine blades, have bigger resistance to traction and compression, larger resistance to flexion and larger resistance to torsion (Rappaz, 1989).

The interaction between the parameters involved in the columnar to equiaxed transition (CET) has gained considerable attention over the last three decades in order to understand the structure of ingot castings and to optimize the industrial practice (Spittle, 2006).

The mechanical properties of the ZA alloys are generally considered satisfactory from room temperature up to about 100°C. Above this temperature, the applications are diminished due to the decrease in the creep resistance. It is also known that metal matrix composite

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