Nanostructure formation and improved surface hardness of hypereutectic Al-17.5Si alloy induced by high current pulsed electron beam treatment

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Abstract

A hypereutectic Al-17.5Si alloy (in wt.%) was subjected to high current pulsed electron beam (HCPEB) treatment. The surface layer of HCPEB-treated sample was analyzed through scanning electron microscope (SEM) and transmission electron microscope (TEM). The investigation results show that the "halo" microstructure centered on primary Si is formed when the top surface is rapidly melted and solidified under the action of HCPEB. The phase boundary of Al and Si phases becomes indistinct due to the element diffusion. By TEM observation, nano-silicon particles are uniformly distributed in the near-surface layer, whose size is about 5_˜100nm. The dispersive distribution of nano-silicon is considered as a possible explanation for "halo" formation. Nano-subgrains with size of 70_˜100nm are formed in the matrix, and a few tiny nano-silicon particles appear in the subgrain boundaries. By hardness test, it is found that the surface hardness of 35-pulse treated sample is enhanced by 40.8% as compared to initial sample, which is attributed to nano-scale strengthening from silicon grains and subgrains.

Keywords: High current pulsed electron beam, "Halo", Nano, silicon, Nano, subgrains, Surface hardness, Al, 17.5Si alloy

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