Solid State Recycling of Magnesium Alloys using Equal Channel Angular Pressing.

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Abstract

The aim of this study is to recycle AZ31 (UNS M11311) magnesium alloy chips by solid-state recycling (SSR) approach utilizing a severe plastic deformation technique. The equal channel angular pressing (ECAP) as a severe plastic deformation technique is used to consolidate the AZ31 chips into bulk material. ECAP was originally used to process bulk materials to enhance their mechanical properties due to its large imposed strain. Hence, it is recently used to successfully consolidate metallic powder and chips. In addition to the successful overcoming of the environmental, economical, and technical issues of recycling Mg alloy using conventional remelting process, starting with chips with different orientation during SSR process might result in material with weaker crystallographic texture and hence lower anisotropy. In the current study the quality of consolidation is investigated as a function of ECAP passes. Detailed metallographical, chemical and mechanical characterization as well as texture simulation were carried out on the recycled AZ31 samples.

The AZ31 mg alloy chips have been successfully recycled using one and two ECAP passes following route A in which the billet is continuously processed without rotation between successive passes. The degree of consolidation quality was found to be highly dependent on the number of ECAP passes. The density of recycled material was significantly improved by increasing the number of passes. Furthermore, the hardness of solid state recycled AZ31 materials was found to be higher than those of the starting cast AZ31 and it increases with increasing number of passes. The breakage of oxide layers around the chips boundaries and the distribution of the oxide particles within the matrix have caused particles dispersion strengthening and hence increased in hardness. The texture evolution of solid state recycled AZ31 after one pass and two passes was successfully predicted using a visco-plastic self-consistent (VPSC) crystal plasticity model. It was found that the recycled AZ31 samples using ECAP developed strong texture despite the starting random texture. The recycled AZ31 exhibited a strong basal texture that was further strengthened after the second ECAP pass following route A.