Praca doktorska

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„Kształtowanie struktury i własności odlewniczych stopów Al-Mg w procesach obróbki cieplnej i intensywnego odkształcenia plastycznego”

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Abstract

The aim of the PhD dissertation was to produce a material with a favourable combination of properties – high mechanical strength and plasticity as well as the characterization of the microstructural phenomena in two different types of Al-Mg alloys subjected to the heat treatment and plastic deformation using the ECAP process. The research results presented in this work focuses on the influence of applied treatment scheme on the structure and mechanical properties of investigated alloys.

In order to prove the work thesis a number of extensive experimental studies were carried out, which were subjected to detailed analysis. The main research, which is the main part of the dissertation, focuses on the analysis of the influence of the applied heat and plastic deformation treatment scheme on the structure and mechanical properties of two Al-Mg alloys. The experimental part of the work is divided into four parts. The first of these includes the determination of the relationship between the cooling rate and the time of structural changes, liquidus temperature, solidus and the nucleation temperature of the Mg-containing eutectic phases, which was performed using ATD thermal-derivative analysis. In the second stage of the research, based on the results of mechanical properties and ATD analysis and by performing a series of experiments involving a combination of several tests, the optimization of heat treatment conditions was performed. In the present work, the phase composition and their morphology were determined using electron microscopy, indicating that the precipitation of the β'-Al_3Mg_2 phase having a hexagonal crystal structure, is responsible for the precipitation strengthening effect in the Al-Mg alloys. An additional strength increase was obtained by the combination of the heat treatment process with a severe plastic deformation using an ECAP method. Further, the mechanical properties of ECAEed samples have been investigated. The presented test results confirmed the beneficial effect of the obtained fine-grained microstructure on the mechanical properties of investigated Al-Mg alloys. The use of artificial ageing after the ECAP process, improved the plasticity of both tested Al-Mg alloys, resulting in a slight decrease in strength properties in relation to the obtained increase in plasticity. In the last stage of the research, the use of a modified die geometry was proposed in order to activate a greater number of slip systems and thus to obtain a greater degree of grain refinement. It has been proved that due to the modification of the ECAP die in the ECAP process it is possible to obtain an increased degree of microstructure refinement, which was confirmed by the results of own research.