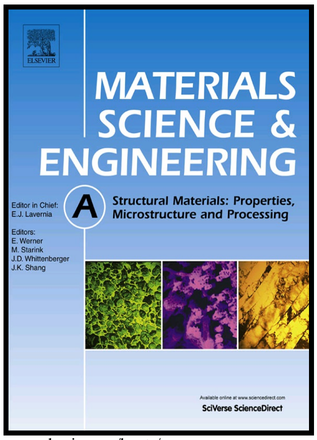
Author's Accepted Manuscript



www.elsevier.com/locate/msea

Microstructure and mechanical properties of thin magnesium plates and foils obtained by lateral extrusion and rolling at room temperature

O.V. Antonova, A.Yu. Volkov, B.I. Kamenetskii, D.A. Komkova

PII: S0921-5093(15)30559-1
DOI: http://dx.doi.org/10.1016/j.msea.2015.10.097
Reference: MSA32948

To appear in: *Materials Science & Engineering A*

Received date: 21 July 2015
Revised date: 20 October 2015
Accepted date: 25 October 2015

MICROSTRUCTURE AND MECHANICAL PROPERTIES OF THIN MAGNESIUM PLATES AND FOILS OBTAINED BY LATERAL EXTRUSION AND ROLLING AT ROOM TEMPERATURE

O.V. Antonova, A.Yu. Volkov*, B.I. Kamenetskii, D.A. Komkova
M.N. Miheev Institute of Metal Physics, Ural Branch, Russian Academy of Sciences,
18 S.Kovalevskaya St., Ekaterinburg, 620137 Russia
*) volkov@imp.uran.ru

Abstract – A novel processing method was applied for production of thin magnesium plates. At the first step of this procedure, a lateral extrusion (LE) method is involved to form a long magnesium plate. The deformation by LE method was carried out using a hydraulic press, in one pass, at room temperature. As a result of LE, the fine-grained structure with grain size near 8 μm and weakened basal texture occur in the obtained 1-mm magnesium plate. Only small fraction of twins on the planes that are the most typical of magnesium were revealed in the plate. At the next step of processing method, this plate was cold rolled to produce foils of different thicknesses. The microstructure of the foil of 120 μm thick consists of large – 15÷20 μm – grains, which have a necklace-like array of ultra-fine grains with a typical size near 2 μm. After rolling to foil of 10 μm thick, any size refinement of the microstructure was not revealed. The elongation-to-failure of 120-μm thick foil at the strain rate 7×10^{-6} s^{-1} is more than 20%.

Keywords: A. Microstructure, mechanical characterization; B. Magnesium; C. Bulk deformation; D. Plasticity.

1. Introduction

Magnesium-containing alloys are considered as promising materials for lightening frameworks produced in the automobile and the aerospace industry, for fabrication of relatively light housings of electrical devices, electronic equipment, and so on [1]. However, the plasticity of both magnesium and its alloys at room temperature is extremely low [2]. An exception is the single crystals of magnesium that have an advantageous orientation for basal slip [3]. This result is essentially attributed to the limited number of slip systems owing to the hexagonal crystal structure of magnesium. The deformation of magnesium at room and lower temperatures proceeds mainly by basal planes, and only upon heating the slip on the planes of pyramid and prism is activated [1, 2]. That is why articles of magnesium alloys are fabricated at temperatures of 200-450°C.

It has been reliably established that severe plastic deformation (SPD) leads to grain refinement due to the occurrence of continuous dynamic recrystallization (CDR) during the pressing process and to significant improvements in the strength and ductility of magnesium [4-6]. Though several SPD processing techniques are now quite available, the most promising procedure is the equal channel angular pressing (ECAP), which has a capability of the production of relatively large bulk samples [4, 5, 7, 8]. ECAP technique is especially effective in reducing the grain size when pressing is conducted at lower temperatures, at which the occurrence of grain growth is limited. Also, it was found that after ECAP, the formability of magnesium increased due to shear texture