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The process of ultra-fine wire drawing for magnesium alloy with the guaranteed restoration of ductility between passes

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Abstract

The solution to the problem of production of ultra-thin (0.05 mm) wire made of magnesium alloy MgCa0.8 with an improved biocompatibility was developed. Extruded rod with a diameter equal to 1 mm was used as the input to the drawing process. The technology comprises two stages – the drawing process in a heated die and the cold drawing process. The hot drawing allows the technological plasticity of the material to be increased. However, it cannot be used to obtain a wire with a diameter smaller than 0.1 mm because of unstable results and, therefore, a high risk of wire damage. According to the above, the second stage of the process was the cold drawing to the final diameter 0.05 mm with the restoration of ductility between passes. The model of the restoration of ductility is based on the hypothesis that the degree of restoration of ductility is proportional to the degree of recrystallization of the deformed material. The model of MgCa0.8 alloy static recrystallization (SRX) was proposed and calibrate based on the relaxation tests performed with the physical simulator GLEEBLE 3800.

The limits of the applicability of such an approach were determined by using the in situ analysis of the microcracks that appear in the alloy in the tension test. These studies were helpful to obtain cold drawing deformation scheme. On the other hand, the development of the model of recrystallization and its implementation into the FEM model of drawing made it possible to determine the parameters of annealing. The calculated parameters enabled annealing in the process of drawing using a continuous furnace. The result of the described solution is a wire with a diameter equal to 0.05 mm with high ductility.