AGH University of Science and Technology

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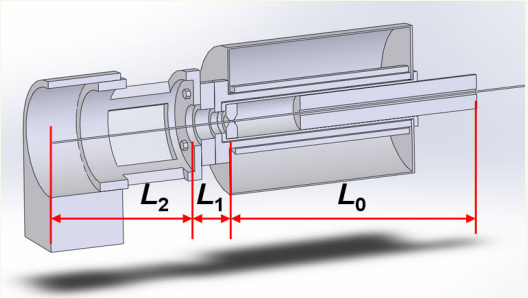
Department of Applied Computer Science and Modelling

Project 2012/05/B/ST8/01797

Development of multi- scale model of recrystallization, that occurs in fine wires from biocompatible Mg alloys during drawing at elevated temperature for diameters of wires, comparable with the size of grains of microstructure

Objective: Development of mathematical model of recrystallization for MgCa08 alloy and implementation of this model into the FE code that simulates the process of wire drawing.

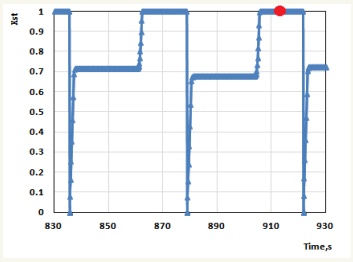
Equipment for drawing

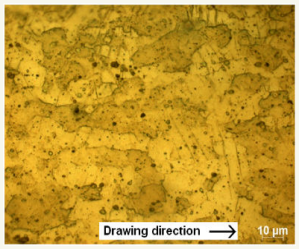


Set of tools for drawing process in the heated die: L_0 – pre-heating zone, L_1 – high temperature zone, L_2 – cooling zone.

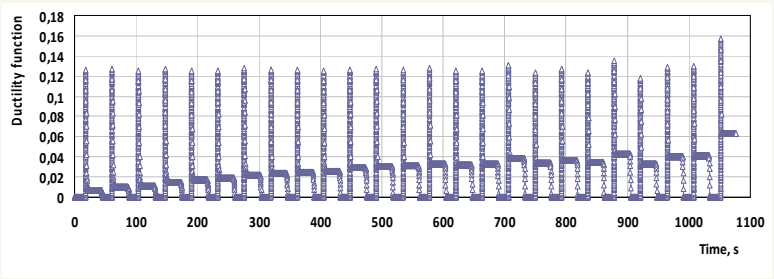
JMAK model of recristalization

$$X_{SRX} = 1 - \exp\left[c_4\left(\frac{\tau}{\tau_{0.5}}\right)^n\right] \qquad \tau_{0.5} = c_1\varepsilon^{c_2} D_0 \exp\left(\frac{c_3}{RT}\right)$$





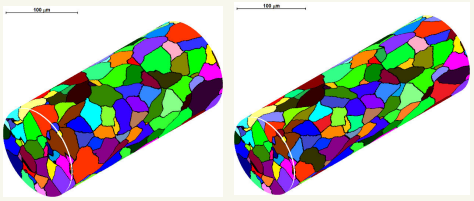
Model of ductility coupled with recrystallization

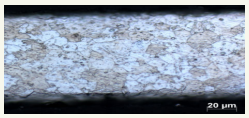


$$D^{(m+1)} = D^{(m)} + \frac{\bar{\xi}^{(m)}\Delta\tau^{(m)}}{\varepsilon_f\left(k_f, t^{(m)}, \bar{\xi}^{(m)}\right)} - D^{(m)}\Delta X_{SRX}^{(m)}$$

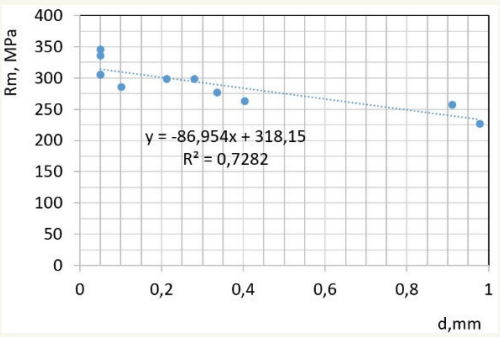
Results of simulation of ductility parameter D for drawing velocity 10 mm/s and temperature 350ºC.

Cellular automata model of recrystallization





Produced wire, d=50 µm



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Publications:

1. A. MILENIN, P. KUSTRA, D. BYRSKA-WÓJCIK FEM-BEM code for the multiscale modeling and computer aided design of wire drawing technology for magnesium alloys // Advanced Engineering Materials; 2014 vol. 16 iss. 2, p. 202–210
2. D.S. SVYETLICHNYY, P. KUSTRA, A. MILENIN Modeling with FCA-based model of microstructure evolution of MgCa08 alloy during drawing of thin wire in heated die // Archives of Metallurgy and Materials / — 2015 vol. 60 iss. 4, p. 2721–2727.