Institute of Physics of the Czech Academy of Sciences

SEMINAR

18/04/2023 at 10:00

Meeting Room 2NP 1.32 in the Solid Building

Na Slovance 1999/2, Prague 8

Jaroslav Čapek

Department of Functional Materials, Division of Condensed Matter Physics

Deformation mechanisms in Zn-Mg-Ca/Sr alloys

During my internship at the Max-Planck-Institüt für Eisenforschung GmbH (MPIE) I have dealt with the investigation of the deformation mechanisms in a Zn-Mg0.8-Sr0.2 biodegradable alloy. My activities during the internship and post-internship period could be divided into three main parts, which are mentioned below.

i) The mechanical behaviour of the extruded Zn-Mg0.8-Sr0.2 alloy was investigated at the temperature of human body (37 °C). To explain the mechanical response to the elevated temperature, the elemental chemical composition and distribution was investigated using, atom probe tomography, microstructure at various levels was analysed using scanning and transmission microscopy and electron back-scattered diffraction (EBSD). Advanced techniques, such as cross-correlated EBSD or electron channelling contrast imaging were used for the analysis of the deformed materials as well. The obtained results clearly proved that significant recovery and recrystallization took place during the deformation at 37 °C in contrast to the room temperature. Based on the obtained results, modifications of the design of the Zn-based materials enhancing temperature and mechanical stability were suggested.

ii) Microstructure of the Zn-Mg0.8-Sr0.2 alloy treated by equal channel angular pressing at various conditions was investigated in detail, mainly by EBSD. Based on the obtained results, deformation and recrystallization mechanisms taking place during the treatment have been proposed. As an optimum temperature, the temperature of 200 °C was found. At lower temperatures, the microstructure was not fully recrystallized, while at higher temperatures (350 °C) coarse-grained, twinned structure with poor mechanical behaviour was obtained. This was explained by a suppressed activity of the c + a 2nd order pyramidal slip system at high temperatures.

iii) I also learnt some basics with the DAMASK simulation software developed at MPIE. Due to that I had to learn also some basics of programming in Python language, because the pre-processing and a part of post-processing is done in Python. During the Python training, I wrote codes for a semi-automatic comprehensive evaluation of tensile and compressive tests. Now I am preparing a code for the evaluation of the creep tests.

This event is supported by ESIF and MEYS
(Project **FZU researchers, technical and administrative staff mobility** – CZ.02.2.69/0.0/0.0/18_053/0016627)

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Drahomír DVORSKÝ

Department of Functional Materials, Division of Condensed Matter Physics

LPSO phases in magnesium alloys

Magnesium alloys are desirable in the aviation and automotive industries as they reduce fuel consumption and CO2 emissions. The advanced alloy Mg-Y-Zn is an excellent candidate for achieving exceptional mechanical properties through extreme plastic deformation which was prepared through the powder metallurgy method by Kawamura et.al. Improved mechanical properties are associated with the presence of specific phases with long period stacking order (LPSO). However, these phases have an extremely negative effect on corrosion resistance.

LPSO phases can be dissolved by solid solution treatment and by subsequent aging it is possible to prepare a homogeneous microstructure consisting of cluster-arranged layers with few similarities with LPSO phases. This specific microstructure is called Mille-Feuille microstructure which contains hard (clusters) and soft (Mg matrix) layers. Through thermomechanical processing, the recrystallization occurs at the grain boundaries creating regions of fine equiaxed grains which improves ductility, and prolonged worked grains which improve strength. Therefore, there exists the optimal volume fraction of recrystallized grains which provides an ideal compromise between strength and ductility. This volume fraction can be adjusted by extrusion conditions. Therefore, in this work, Mg-Y-Zn alloy was prepared by rapid solidification followed by proper heat treatment and extrusion at different conditions.

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