

Semester report

by **Pham Tran Hung**

PhD Program: Materials science

Supervisor: Prof. Jenő Gubicza

PhD Thesis title: Lattice defects and mechanical properties of novel multicomponent materials

Introduction:

This PhD thesis focuses on exploring the lattice defects, mechanical properties and their correlation of multi-principal element alloys (MPEAs).

Description of research work in current semester:

CoCrFeNi equimolar MPEA specimens are provided by international partners. The materials were processed by high-pressure torsion (HPT) up to 10 turns. This results in severe plastic deformation. The edge of the HPT disk was examined using differential scanning calorimetry (DSC) in order to investigate the thermal stability of the microstructure. The characteristic temperatures of the microstructure evolution were studied up to 1000K, and two distinct DSC peaks were found. The samples are then annealed to temperatures before and after the DSC peaks (500 K, 750 K and 1000 K). The phase analysis of the annealed samples was carried out using X-ray diffraction (XRD), and the materials show no phase separation throughout the annealing process. The microstructure of the annealed samples was investigated quantitatively using Convolutional Multiple Whole Profile (CMWP) method, characterizing the crystallite sizes, dislocations and planar faults of the samples. Additionally, the grain size was determined from transmission electron microscopy (TEM) evaluation, and the hardness of the samples was measured using Vickers indentation test. The results were published in the journal "Materials Characterization".

In addition to my PhD topic, I also studied metallic foams in the frame of a Hungarian-Korean research project. X-ray line profile analysis (XLPA) was conducted on Cu nanofoams synthesized with varying parameters and/or annealed to different temperatures. Samples prepared by international partners were also investigated using XLPA. Series of Mg alloys (AZ80 and AZ80-SiC) and MPEAs (Fe40Mn40Co10Cr10, Fe35Mn35Co10Cr10Ni10, and Co33Ni33Cr19Mn15) processed by HPT were studied using CMWP method; and series of CuZr and TiMo alloys processed by free bending were measured and being analyzed.

Publications:

1. Krajňák, Tomáš, Miloš Janeček, Peter Minárik, Jenő Gubicza, Pham Tran Hung, František Nový, Arseniy Raab, Georgy Raab, and Rashid Asfandiyarov. "Microstructure Evolution in Cu–0.5 wt% Zr Alloy Processed by a Novel Severe Plastic Deformation Technique of Rotational Constrained Bending". The article was published in journal "Metals" 11, no. 1 (2021): 63.
2. Pham Tran Hung, Megumi Kawasaki, Jae-Kyung Han, János L. Lábár, and Jenő Gubicza. "Microstructure evolution in a nanocrystalline CoCrFeNi multi-principal element alloy during annealing". The article was published by journal "Materials Characterization" (2021) : 110807.

3. Pham Tran Hung, Megumi Kawasaki, Jae-Kyung Han, János L. Lábár and Jenő Gubicza “*Thermal Stability of a nanocrystalline HfNbTiZr multi-principal element alloy processed by high-pressure torsion*”. The article was published by journal “Materials Characterization” 168 (2020): 110550.
4. Péter Jenei, Gigap Han, Pham Tran Hung, Heeman Choe and Jenő Gubicza “*Influence of pack cementation time on the microstructure of Cu nanofoams processed by dealloying*”. The paper was accepted by "IOP Conference Series: Materials Science and Engineering" (2020).
5. Péter Jenei, Csilla Kádár, Gigap Han, Pham Tran Hung, Heeman Choe, and Jenő Gubicza “*Annealing-induced Changes in the Microstructure and Mechanical Response of a Cu Nanofoam Processed by Dealloying*”. The article published by the journal “Metals” 10, no. 9 (2020): 1128.
6. Tomáš Krajňák, T. Krajňák, M. Janeček, P. Minárik, J. Veselý, P. Cejpek, J. Gubicza, P.T. Hung, D. Preisler, F. Nový, A.G. Raab, G.I. Raab, and R. Asfandiyarov. “*Microstructure evolution and mechanical properties of cp-Ti processed by a novel technique of rotational constrained bending*”. The article was submitted to journal “Metall. Mater. Trans. A”.

Conference in current semester:

7. Pham Tran Hung, Megumi Kawasaki, Jae-Kyung Han, János L. Lábár and Jenő Gubicza “*Thermal Stability of the Microstructure and the Hardness of Multi-principal Element Alloys processed by Severe Plastic Deformation*”. The abstract was submitted to the Material Research Society spring conference, scheduled to be held at 18-23 April 2021.
8. Pham Tran Hung, Péter Jenei, Csilla Kádár, Gigap Han, Heeman Choe, and Jenő Gubicza “*Influence of Pack Cementation Time and Annealing on Microstructure of Cu Nanofoams processed by Dealloying*”. The abstract was submitted to the Material Research Society spring conference, scheduled to be held at 18-23 April 2021.

Studies in current semester:

Subject code	Subject name	Lecturer	Credits	Requirements	Class per week (T/P/L)	Grades
FIZ/1/0 37E	Amorphous alloys	Révész Ádám Dr.	6	exam	2/0/0	Excellent
FIZ/1/0 16E	Physical materials science II.	Kovács Zsolt Dr.	6	exam	2/0/0	Excellent