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:

The specimens are provided by international partners. The materials studied are CoCrFeNi and HfNbTiZr with equal elemental ratios, and underwent an SPD process by high-pressure torsion (HPT) up to 10 HPT turns. This results in samples with different shear strains, depending on the number of HPT turns, as well as the position from the axis of applied torsion. Moreover, the thermal stability of the microstructures is examined using differential scanning calorimetry (DSC). From the results of DSC, three different temperatures were selected, to which the HPT samples are annealed and further investigation into their microstructures was conducted with X-ray line profile analysis (XLPA). It was revealed that for HfNbTiZr underwent SPD, there is phase separation at high temperature, and phase analysis was carried out using X-ray diffraction. One series of samples (HfNbTiZr processed by 10 HPT turns at the periphery of the HPT disk, annealed to 740K, 890K and 1000K) was also studied by electron microscopy for direct results of microstructure, as well as obtaining elemental compositions. These samples are investigated with XLPA for characterization of crystallite sizes, dislocations and planar faults. Convolutional Multiple Whole Profile (CMWP) method was used in order to quantitatively determine the lattice defects properties for each phase. The hardness of these samples is also measured with nano-indentation hardness tests. CoCrFeNi is under similar investigations. From the DSC results, these samples were chosen to be annealed to 500K, 750K and 1000K. XLPA, hardness and TEM evaluations for CoCrFeNi samples are being conducted.

XLPA is also conducted on other samples prepared by international partners. Series of Mg alloys (AZ80 and AZ80-SiC) and MPEAs (Fe40Mn40Co10Cr10, Fe35Mn35Co10Cr10Ni10, and Co33Ni33Cr19Mn15) processed by HPT, and Ti processed by rotational constrained bending (RCB)are measured and being analyzed.

Conference in current semester:

- Pham Tran Hung, Megumi Kawasaki, Jae-Kyung Han, János Lábár and Jenő Gubicza*"Thermal stability of microstructure and hardness of high-entropy alloys processed by severe plastic deformation".* The abstract was submitted to the Junior Euromat 2020 conference, scheduled to be held at 15-19 November 2020.

Publications:

- 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 is published at "IOP Conference Series: Materials Science and Engineering" (2020).
- 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 paper is submitted to the journal "Materials Characterization" (2020).

Studies in current semester:

Subject code	Subject name	Lecturer	Credits	Requirements	Class per week (T/P/L)	Grades
FIZ/1/001E	Nanophase metals	Bakonyi Imre Dr.	6	exam	2/0/0	-
FIZ/1/015E	Physical materials science I.	Groma István Dr.	6	exam	2/0/0	Excellent
FIZ/1/031E	Technology of Materials	Groma István Dr.	6	exam	2/0/0	Excellent