*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:

One of the most important tasks of materials science is the development of new materials with advanced functional performances. In last decades, several novel multicomponent materials have been developed with prominent properties, and one of such materials is high-entropy alloys (HEAs), which exhibit high strength, good conductivity, as well as excellent corrosion resistance and thermal stability. Additionally, plastic properties of HEAs can be improved by an appropriate selection of lattice defect structure. This can be realized by severe plastic deformation (SPD) or thermal treatments. In the frame of the planned project, we will study the correlation between the lattice defect structure (grain boundaries, planar faults and dislocations) and the mechanical performance of HEAs. Our main goal for all the studied materials is to recognize the influence of the type and density of lattice defects on the mechanical properties which are important from the point of view of practical applications. Additionally, we investigate the relationship between the processing conditions and the lattice defect structure of novel multicomponent materials. Moreover, the thermal stability of the defect structure and phase composition of the multicomponent materials is also studied.

## 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 a 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. The samples are investigated with X-ray line profile analysis (XLPA) for characterization of crystallite sizes, dislocations and planar faults. 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 were annealed and further investigation into their microstructures was conducted with 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.

Furthermore, I have also contributed to a Hungarian-Korean shared project, investigating Cu nanofoams. The first results are submitted to "IOP Conference Series: Materials Science and Engineering".

## 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 submitted to "IOP Conference Series: Materials Science and Engineering" (2020).

**Studies in current semester:**

| Subject code | Subject name | Lecturer | Credits | Require-ments | Class per week (T/P/L) | Grades |
|---|---|---|---|---|---|---|
| FIZ/1/014E | Analytical electron microscopy | Lábár János Dr. | 6 | exam | 2/0/0 | Good (4) |
| FIZ/1/040E | Bulk nanostructured materials | Gubicza Jenő Dr. | 6 | exam | 2/0/0 | Excellent (5) |