2.semester report

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PhD program: Materials science and solid state physics

Supervisor: Gubicza Jenő

Thesis title: Correlation between processing, microstructure and mechanical properties of novel multicomponent thin films

Introduction:

In the last decades, several novel multicomponent materials comprising 3-5 different chemical elements were developed. For instance, high-entropy alloys (HEAs) contain at least four components, usually with equal fractions. These structures are stabilized by the large configuration entropy. Due to the severe lattice distortion and the sluggish diffusion, HEA materials exhibit high strength, good ductility as well as excellent corrosion resistance and thermal stability. Therefore, HEAs are considered as advanced structural materials with outstanding mechanical properties. HEAs are intensively studied materials due to their impressive mechanical properties, such as very high strength even at high temperatures. HEAs with many different compositions have already been successfully processed in bulk form. The synthesis of HEA materials exploits many different methods such as melt spinning, electromagnetic stirring, vacuum arc melting, or mechanical alloying. However, there is a demand for the production of these materials in the form of thin films as they can be used as hard coatings in many practical applications. During my MSc, I worked on the production of HEA thin films and participated in an elaboration of a novel physical vapor deposition method to produce HEA thin films. In this work, we demonstrated that HEA thin films can also be processed using a multiple beam sputtering system in PVD, which does not require preliminary manufacturing of HEA targets, but rather uses commercially pure metal targets. This study also demonstrated the capability of this new multiple beam sputtering technique for the production of compositional gradient samples with a wide range of elemental concentrations, enabling combinatorial analysis of multiple elements high-entropy alloy. The effect of the chemical composition on the structure and properties of HEA films can be studied on combinatorial samples. We used synchrotron X-ray diffraction to create a diffraction map for one of these gradient samples, thereby we can examine the changes of the microstructure as a function of the chemical composition.

Research work in the current semester:

- This semester, I started to work on a new method for evaluating big amounts of diffractograms via machine learning in the CMWP analysis.

- I also started a new project to produce HEA thin films by electrolytic thin film deposition.

- I continued my work on a different series of ZK60 samples.

Publications:

N. Fakhar, M. Sabbaghian, P. Nagy, K. Fekete, J. Gubicza, *Superior low-temperature superplasticity in fine-grained ZK60 Mg alloy sheet produced by a combination of repeated upsetting process and sheet extrusion*, Materials Science and Engineering: A, Volume 819, 2021, 141444

And the following accepted for publication in the special issue of Materials:

P. Nagy, N. Rohbeck, Z. Hegedűs, J. Michler, L. Pethö, J. Gubicza *"Composition dependence of the microstructure and hardness in a multibeam sputtered nanocrystalline Co-Cr-Fe-Ni compositional complex alloy film"*

And an article is under review at the Journal of Alloys and Compounds:

N. Fakhar, M. Sabbaghian, P. Nagy, K. Fekete, J. Gubicza, *Correlation between microstructure and texture evolution and shear and tensile properties of ZK60 Mg alloy fabricated by rolling and sheet extrusion*

Studies in the current semester:

subject code	subject name	course type	number of classes	number of credits	Lecturers	Grades
FIZ/1/031E	Technology of Materials	Lecture	2	6	Groma István Dr.	Excellent (5)
FIZ/1/024	Lattice defects II.	Lecture	2	6	Gubicza Jenő Dr.	Excellent (5)
FIZ/3/089	Deep learning and machine learning in natural sciences	Lecture	2	6	Biricz András Mátyás, Csabai István Dr., Olar Alex, Pataki Bálint Ármin, Udvarnoki Zoltán András	Excellent (5)

Teaching in the current semester:

subject code	subject name	course type	number of classes
fizlab3f19la	Modern Physics Laboratory	Laboratory	4