I. Physikalisches Institut (IA) Physik neuer Materialien

RWTH AACHEN UNIVERSITY

I. Physikalisches Institut (IA)
Phasenwechselmaterialien
Prof. Dr. rer. nat. Matthias Wuttig

Topic for a Bachelor Thesis

„GUI design and optimization of deposition parameters “

Multi-component High Entropy Alloys have caught the attention of several researchers for their favorable mechanical properties, e.g. high fracture toughness, and both resistance to an oxidizing or corrosive environment [1]. The enhanced properties of High Entropy Alloys are related to the entropy-driven formation of simple phases [2]. However, the change of the properties of this material after oxidation, leading to **High Entropy Oxides**, is poorly understood. High Entropy Oxides have been recently studied by Rost et al. [3], who verified the entropy stabilization ansatz and showed that configurational disorder provides an alternative route to new materials discovery. Rost et al. [3] produced the HEOx by laser evaporation of the individual oxide species.

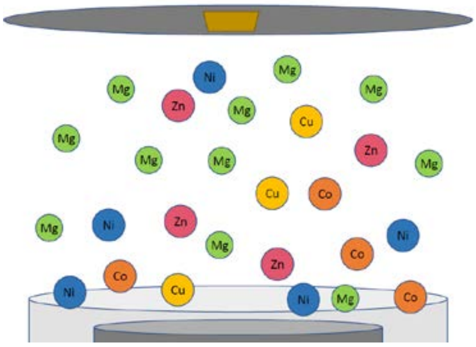

Fig 1: Sketch of the deposition of (MgCoCuNiZn)O.

We investigate the optical, electrical and mechanical properties of the particular HEOx: (Mg-Co-Cu-Ni-Zn)O. Surprisingly, we observe that the HEOx thin films produced at RWTH by reactive sputtering exhibit a pronounced, broad sub-bandgap absorption and a peculiar optical behavior. The correlation between the tunable optical properties of (Mg-Co-Cu-Ni-Zn)O thin films and its structural changes is investigated.

Reactive Sputtering allows to deposit a compound by introducing a reactive gas (oxygen in the case of oxides) into the plasma which is typically formed by an inert gas such as argon (most common). In this process the reactive gas is “activated” by the plasma and chemically reacts with the target material which is subsequently deposited on the substrate [4]. At RWTH the reactive sputtering is performed with the MYTHIC chamber, which is the abbreviation of **M**ulti-La**Y**er **Th**in F**I**lm **C**oater. It includes six independent cathodes and an automatically rotatable sample holder that positions each of the 24 possible samples exactly above the target.

Moreover, deposition parameters as time, power, voltage, gases proportions and especially the oxygen partial pressure used to deposit the (Mg-Co-Cu-Ni-Zn)O thin films are tuning parameters of the optical properties of the system. Precisely controlling these parameters also allows to closely control the stoichiometry, structure and reproducibility.

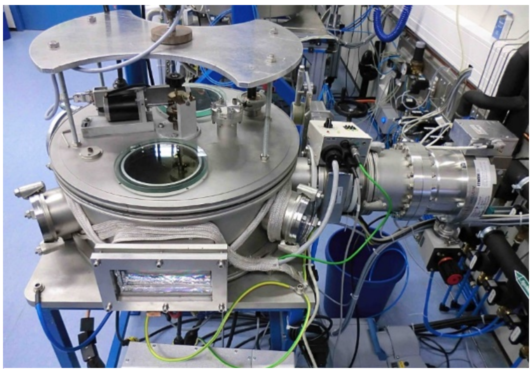

Fig 2: Picture of the MYTHIC chamber.

The aim of this thesis is to understand the effect of the deposition conditions in the properties of the HEOx films. For this purpose, the main task will be the development of a user interface that allows to correlate the control parameters used in different deposition runs with the change in the sample properties. The expected result is an optimization of the process ensuring the same deposition conditions, not only for one sample, but all of them. This work will have a major impact on the further investigations of the Sputter group.

Desirable Skills: GUI programming, Data Analysis, Experimental skills.

[1] Butler, T. M., & Weaver, M. L. (2016). Oxidation behavior of arc melted AlCoCrFeNi multi-component high-entropy alloys. *Journal of Alloys and Compounds*, *674*, 229–244.
[2] Yeh, J.-W. (2006). Recent progress in high-entropy alloys. Annales de Chimie Science Des Matériaux, 31(6), 633–648.
[3] Rost, C. M., Sachet, E., Borman, T., Moballegh, A., Dickey, E. C., Hou, D., … Maria, J. P. (2015). Entropy-stabilized oxides. Nature Communications, 6, 1–8.
[4] M. Ohring. Material Science of Thin Film. Academic Press., 2 edition, 2002

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