MA 24: Miscellaneous: Biomaterials, Magnetic Shape Memory Alloys, Sensors and Actuators (joint session MM/MA)

Time: Tuesday 14:15–15:45 Location: H46

MA 24.1 Tue 14:15 H46

Magnetic and chemical microstructures of Mn-based Heusler compounds studied by small-angle neutron scattering — •Ulrike Zweck, Michael Leitner, Pascal Neibecker, and Winfried Petry — Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, Garching

Ni_2MnZ based Heusler compounds have attracted a considerable amount of attention due to their various appealing properties such as the ferromagnetic shape-memory effect or the magnetocaloric effect. Since the magnetic properties are very sensitive to the degree of structural order in these systems [1], understanding the correlation of these two ordering parameters is crucial.

The magnetic moments are mainly carried by the Mn atoms, which interact ferromagnetically in the $L2_1$-ordered state. However, it has been found that at structural anti-phase domain boundaries the magnetization tends to reverse, leading to atomically sharp ferromagnetic domain walls [2]. To study this interplay of magnetic and structural order as well as the mechanism of coupling of ferromagnetic domains across APD boundaries, we have investigated Ni_2MnAl and $Ni_2MnAl_{0.5}Ga_{0.5}$ powder samples in distinct ordering states via temperature-dependent small-angle neutron scattering (SANS), giving access to the magnetization microstructure. Further, we reproduce the correlation between structural and magnetic order by Monte Carlo simulations.

[1] P. Neibecker *et al.*, Appl. Phys. Lett. **105**, 261904 (2014).
[2] H. Ishikawa *et al.*, Acta Mater. **56**, 4789 (2008).

MA 24.2 Tue 14:30 H46

Atomic disorder in magnetocaloric materials: A roadmap for achieving better performance — •Biswanath Dutta[1,2], Bruno Weise[3], Niclas Teichert[4], Andreas Hütten[4], Anja Waske[3], Fritz Körmann[1,2], Tilmann Hickel[2], and Jörg Neugebauer[2] — [1]Materials Science and Engineering, Delft University of Technology, Delft, Netherlands — [2]Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf, Germany — [3]Institute for Complex Materials, IFW Dresden, Dresden, Germany — [4]Department of Physics, Bielefeld University, Bielefeld, Germany

Understanding and improving magnetic properties of magnetocaloric materials is of great importance for their practical applications. In the quest to enhance these properties, different design strategies have been employed in recent years. Using ab initio calculations, we study the impact of atomic disorder on the martensitic transformation and the magnetic properties in Ni-Mn-based magnetic shape memory alloys (B. Weise et al., Sci. Rep. 8:9147 (2018)). The calculations reveal a remarkable impact of atomic configuration on the structural and magnetic properties of the cubic austenite phase. We also find a delicate interplay of magnetic and chemical orders and the tetragonal distortion during the martensitic transformation, explaining the giant inverse magnetocaloric effect in these alloys. Based on these findings, we qualitatively explain the experimentally observed changes in the magnetocaloric properties after different annealing times. Our investigations thus provide a promising route, i.e., managing disorder with optimal annealing to achieve better magnetocaloric properties.

MA 24.3 Tue 14:45 H46

Stretchable Multidimensional Magnetic-Triboelectric Electronic Skin — •Tianxiao Xiao, Gilbert Santiago Cañón Bermúdez, Jürgen Fassbender, and Denys Makarov — Helmholtz-Zentrum Dresden-Rossendorf e.V., Dresden, Germany

Owing to their unique mechanical properties and abilities of touchless interaction with physical and virtual objects [1-3], magnetic field sensors became an integral part of the electronic skins (e-skins) concept [4,5]. In this work, we report a stretchable magnetic-triboelectric electronic skin (MTES) by the combination of giant magnetoresistive (GMR) sensors and triboelectric nanogenerators (TENG). Here, Co/Cu multilayers and polydimethylsiloxane (PDMS) layer not only form a flexible GMR sensor system but also serve as the electrode and dielectric layer of a single-electrode TENG. This work demonstrates the first sensor system based on both magnetic and triboelectric effects. [1] Makarov, D., et al., Appl. Phys. Rev. 3, 011101 (2016). [2] Cañón Bermúdez, G. S., et al., Nature Electronics 1, 589 (2018). [3] Cañón Bermúdez, G. S., et al., Science Advances 4, eaao2623 (2018). [4] Chortos, A., et al., Nature Materials 15, 937 (2016). [5] Amjadi, M., et al., Adv. Funct. Mater. 26, 1678 (2016).

MA 24.4 Tue 15:00 H46

Hybrid Materials Made from Nanoporous Metals and Electrically Conductive Polymers as Electro-Chemo-Mechanical Actuators — •Benedikt Roschning[1] and Jörg Weissmüller[1,2] — [1]Institute of Materials Physics and Technology, Hamburg University of Technology, Hamburg, Germany — [2]Institute of Materials Research, Materials Mechanics, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany

Nanoporous metals can be used as functional materials like sensors or actuators, due to their high intrinsic, externally accessible surface. The mechanism is based on surface stress variations as a consequence of an applied electrical potential. This stress variation acts on the underlying bulk atoms, resulting in actuation, scaling with the feature size. The environmental stability and structural coarsening due to surface diffusion restricts the materials choice to noble metals like gold or platinum and are still an issue in terms of long-term stability.

Another class of electro-chemo-mechanical actuators are conductive polymers. Their actuation is caused by the incorporation of co-ions between the polymer chains for charge balancing. Within thin films, fast ion exchange is possible, but the stiffness of the underlying substrate limits the effect of actuation.

A combination of both approaches, the coating of the intrinsic surface area of nanoporous metals with electrically conductive polymers, leads to superior electrochemical and actuatoric properties. Within this contribution, we address manufacturing approaches, the electrochemical properties as well as the underlying mechanisms for actuation.

MA 24.5 Tue 15:15 H46

Platform for quantitative analysis of biochemical processes in droplets using nano-sensors. — •Dmitry Belyaev[1], Larysa Baraban[1,2], and Gianaurelio Cuniberti[1,2] — [1]Institute for Materials Science TU Dresden, MBZ, Budapester Str. 27, 01069, Dresden, Germany — [2]Technische Universität Dresden Center for Advancing Electronics Dresden, 01062, Dresden, Germany

Real time monitoring of bio-chemical reactions and processes, e.g. related to the cancer development is highly relevant. This, can be done by implementing miniaturized lab-on-a-chip detecting systems, incorporating microfluidics and Si nanowire field effect transistor (SiNW FET) chip allowing droplet analysis[1]. Here, the chemical reaction of β-galactosidase and ortho-nitrophenol-galactose (ONPG) was detected in a label free format, and the kinetics was analyzed using SiNW EFT. SiNW FET is ion sensitive device and it is able to detect presence of charged molecules or ions in the liquid environment. The reaction was analyzed in a numerous emulsion droplets generated in a microfluidic flow-cell, by means of honeycomb shaped NW FET chip. The flow cell was produced via combination of laser, UV and soft lithography techniques and consists of the droplets generation module and the channel structure with width of about 300μm, and is successfully integrated on silicon chip. We attribute the shift of the Isd current to the change on ionic composition of the media. Comparative data proved successful detection of the reaction.

1)J. Schütt et al., Nano Lett. 2016, 16, 8, 4991-5000

MA 24.6 Tue 15:30 H46

Diamond-based materials interacting with DNA units — Miftahussurur Hamidi Putra[1], Di Liu[1], Chandra Shekar Sarap[1], Pouya Partovi-Azar[2], and •Maria Fyta[1] — [1]Institute for Computational Physics, University of Stuttgart, Stuttgart, Germany — [2]Institute of Chemistry, Martin Luther University Halle-Wittenberg, 06120 Halle (Saale), Germany

Using quantum-mechanical calculations implementing density functional theory, we model the interaction of DNA units with diamond-based structures. For the former, we consider the DNA canonical nucleobases and nucleotides, as well as their modified counterparts. For the material part, we focus on terminated surfaces and nanodiamonds. The latter involve defective spherical diamond particles, as well as diamond-cages, known as diamondoids. We model the interactions of these material structures to the DNA units taking into account the surface termination, bonding arrangement and DNA type. Through our computations, we assess the binding strength, electronic properties, as well as optical spectra and charge dynamics of these diamond/DNA hybrid complexes. In the end, we discuss the relevance of such hybrid materials in realizing novel biosensors for the detection of DNA sequences and their mutations.