MM 36: Topical Session Bulk Nanostrucured Materials VIII - Functional Properties I

Time: Wednesday 15:00–16:30 Location: H 0106

Topical Talk MM 36.1 Wed 15:00 H 0106

Functional Nanomaterials by SPD: Hydrogen Storage, Shape Memory Effect, and Thermoelectricity — •Michael Zehetbauer[1], Maciej Krystian[1], Gerhard Krexner[2], Thomas Waitz[1], Gerda Rogl[1,3], and Peter Rogl[3] — [1]Physics of Nanostructured Materials, Vienna University, Austria — [2]Physics of Functional Materials, Vienna University, Austria — [3]Institute of Physical Chemistry, Vienna University, Austria

From recent efforts to functionalise bulk nanostructured materials, those of hydrogen storage, shape memory effect , and thermoelectricity revealed the strongest progress so far. For SPD processed ZK60 Mg alloy, the hydrogen adsorption/desorption rates are similar or even higher than those from milled nanomaterials. Also, loading/unloading processes are reproducible by at least 1000 cycles markedly exceeding the stability of milled nanomaterials. Controlled SPD processing of Shape Memory Alloys (SMAs) allows to affect not only the SME range but also their superelasticity, revocery stress and cyclic stability, paired with superior ductility and enhanced UTS. SPD processing of ferromagnetic SMAs has a strong impact on the kinetics of the martensitic phase transformation as well. Recently, SPD-mediated nanocrystallization reached record values for the efficiency of thermoelectric materials ('figure of merit ZT'). For p- and n-type skutterudites, HPT yields a marked reduction in grain size and increase in dislocation density. This decreases the thermal conductivity by 40% compared to conventionally milled skutterudites, and increases ZT by at least a factor 2. Work supported by FWF Austrian Science Fund under project S 10403

MM 36.2 Wed 15:30 H 0106

Magnetic Properties of nano-crystalline SPD treated SmFe2 — •Martin Kriegisch[1,2], Roland Grössinger[2], Reiko Sato-Turtelli[2], Frank Kubel[3], Daria Setman[1], Clemens Mangler[1], Martin Peterlechner[1], and Michael Zehetbauer[1] — [1]Physics of Nanostructured Materials, University of Vienna, Boltzmanngasse 5, 1090 Vienna, Austria — [2]Inst. of Solid State Physics, Vienna University of Technology, Wiedner Hauptstr. 8-10; A-1040 Vienna, Austria — [3]Inst. of Chemical Technologies and Analytics, Vienna University of Technology, Getreidemarkt 9, A-1060 Vienna, Austria

High magnetostrictive materials are of great industrial importance, because of their potential application as magneto-mechanical sensor and actuator. The rare-earth intermetallic system SmFe2 exhibits a very high magnetostriction at room temperature. By adding a certain amount of Sm2O3 in the beginning of the melting process, we inhibited grain growth and produced nano-crystalline SmFe2 samples. Moreover we found that the addition of Sm2O3 also leads to a de-coupling of the exchange interaction between the nano-crystalline grains. As a consequence we proved that it is possible to tune SmFe2 from soft to hard-magnetic. After fully characterizing the magnetic and magnetostrictive properties, we investigated the effect of repeated cold-rolling (RCR) on the already nano-crystalline material. The changes of the magnetization and magnetostriction are analyzed and discussed with taking into account the internal stress and the stress-induced anisotropy. This work was supported by the FWF under the NFN-project numbers S10403 and S10406.

MM 36.3 Wed 15:45 H 0106

Magnetooptic Kerr Effect on severely deformed hard and soft magnetic materials — •Peter Jerabek[1], Reinhard Pippan[2], and Heinz Krenn[1] — [1]Karl-Franzens-University Graz, Graz, Austria — [2]Erich Schmid Institute , Austrian Academy of Sciences, Leoben, Austria

Magnetooptic Kerr effect (MOKE) is sensitive to the vector orientation of magnetization and offers a local probe of the domain structure. The high pressure torsion (HPT) of polycrystalline materials causes severe plastic deformation (SPD) [1] with a grain size refinement and a change of the magnetic domain structure (mostly a magnetic hardening). Ring specimens of different strain status (up to $\epsilon = 10$) are cut from HPT-deformed disk samples of ferritic steel and silicon-iron (Fe-3% Si). The boundaries between ultrafine grains (<100 nm) impede the motion of magnetic domain walls (accompanied by Barkhausen jumps) and pins the magnetization to preferred (textured) directions. The magnetic hysteresis measured by conventional induction method is compared with the local probe of polar, longitudinal and transverse MOKE (scanning the HeNe-laser spot over different parts of the HPT-ring sample). An interesting aspect is how SPD influences the strain-induced magnetization of originally magnetic soft Fe-3% Si and magnetic hard alloyed steels on the route from the polycrystalline to the dense nanocrystalline structure.

Financial support by the FWF Austrian Science Fund is appreciated (No. S10407-N16).

[1] M. Zehetbauer et al., Adv. Eng. Mat. 12 (2010), 692.

MM 36.4 Wed 16:00 H 0106

Strength and conductivity of graded Cu-particle reinforced aluminium processed by accumulative roll bonding — •Mathis Ruppert, Christian Werner Schmidt, Heinz Werner Höppel, and Mathias Göken — Institute I: General Materials Properties, Department Materials Science and Engineering, Friedrich-Alexander-Universität Erlangen-Nürnberg, 91058 Erlangen, Germany

Among the different processes of severe plastic deformation, accumulative roll bonding (ARB) is most prominent for production of ultrafine-grained sheet materials and has been studied extensively regarding microstructural evolution and mechanical properties. Besides the conventional ARB-processing route it is also possible to produce tailored multicomponent materials. In this context, particle reinforcement is of special interest, because of the manifold varieties of particles and distributions to tailor ultrafine-grained materials.

Applying particles in a highly controlled manner by air gun spraying from aqueous suspensions is used in this work as a method to introduce copper particles (d~1 micron) into aluminium AA1050A during ARB. Moreover it is demonstrated that the spatial distribution of particles within the sheet is widely controllable. Therefore homogeneous as well as continuously graded distributions can be achieved in all three dimensions of the sheet material. By this freedom of design, mechanical properties as well as electrical conductivity can be tailored rather locally within one sheet.

MM 36.5 Wed 16:15 H 0106

Hysteresis measurements of HPT treated Fe-Al — •Roland Grössinger[1], Nasir Mehboob[1], Martin Kriegisch[1,2], Reiko Sato-Turtelli[1], Andrea Bachmaier[3], and Reinhard Pippan[3] — [1]Institute of Solid State Physics, Vienna University of Technology, Wiedner Hauptstr. 8-10/E138; 1040 Vienna, Austria — [2]Physics of Nanostructured Materials, University of Vienna, Boltzmanngasse 5, 1090 Vienna, Austria — [3]Erich Schmid Institute of Materials Science, ÖAW Jahnstrasse 12, 8700 Leoben, Austria

Low cost magnetostrictive materials that exhibit a large magnetostriction at low saturation field combined with a high mechanical strength and a good ductility are of great interest for applications in magneto-mechanical sensors and actuators. Substituting Fe by non-magnetic Al causes a strong increase in magnetostriction mainly due to metastable equilibrium conditions among the disordered A2 and an ordered B2 and/or DO3 structure. The magnetostrictive properties of these alloys were already studied intensively in the past. For industrial applications the frequency dependent hysteresis properties (coercivity, permeability, losses) are of great importance. For this purpose the frequency behavior of the hysteresis loop of materials with enhanced magnetostriction was studied in a frequency range between 0.5 Hz and 200 Hz. Using this method the effect of a plastic deformation at different temperatures using the High Pressure Torsion (HPT) technique was investigated. The results were analyzed applying a new eddy-current based model on the frequency dependence of the coercivity as well as losses.