MM 53: Liquid and Amorphous Metals

Processing

Time: Thursday 10:15–11:30 Location: TC 010

MM 53.1 Thu 10:15 TC 010

Cluster-assembled Metallic Glasses — •Cahit Benel[1], Arne Fischer[1], Aline Léon[2], Anna Zimina[2], Mohammed Reda Chellali[1], Robert Kruk[1], and Horst Hahn[1,3] — [1]Institute of Nanotechnology, Karlsruhe Institute of Technology, 76344, Eggenstein-Leopoldshafen, Germany — [2]Institute for Photon Science and Synchrotron Radiation, Karlsruhe Institute of Technology, 76344, Eggenstein-Leopoldshafen, Germany — [3]Joint Research Laboratory Nanomaterials, Technische Universität Darmstadt, 64287, Darmstadt, Germany

Contrary to rapidly quenched metallic glasses, cluster-assembled metallic glasses (CAMGs) have precisely controlled building blocks in terms of their chemical composition and cluster size. Our state-of-the-art cluster ion beam deposition system allows us to deposit various cluster-based films under well-defined conditions. Furthermore, different compaction scenarios can be realized by varying the impact energies of the clusters. A series of amorphous FeSc samples were deposited with various impact energies. The magnetic properties of the samples can be tailored by the impact energy, which affects the ferromagnetic to paramagnetic transition temperature. No evidence of oxidation was found by the X-ray absorption fine structure spectroscopy analyses. The distinct difference in magnetism of chemically identical amorphous alloys is an evidence for a novel atomic structure existing in CAMGs and can provide a fundamental understanding of the structure-material property relation.

MM 53.2 Thu 10:30 TC 010

Ni-Ti nanoglasses: amorphous structure, and magnetic properties — •Mohammed Reda Chellali[1], Sree Harsha Nandam[1], Suzhi Li[1], Leonardo Velasco Estrada[1], Robert Kruk[1], and Horst Hahn[1,2] — [1]Institute of Nanotechnology, Karlsruhe Institute of Technology, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany — [2]KIT-TUD Joint Research Laboratory Nanomaterials, Institute of Materials Science, Technische Universität Darmstadt (TUD), Jovanka-Bontschits-Str. 2, D-64287 Darmstadt, Germany

The so-called nanoglasses display very spectacular properties, such as highly catalytic activity, mechanical performance, or magnetic characteristics, which differ significantly from any known amorphous mixtures. Here, Ni50Ti50 the nanometer-sized glassy particles are generated by means of inert-gas condensation (IGC). Elemental segregation of Ni and Ti is observed in consolidated nanoglasses. The structure of the nanostructured metallic glasses is found to consist of nanometer-sized amorphous regions which are connected by glass-glass interfaces. It is shown that Ni50Ti50 nanoglass is a ferromagnetic whereas the amorphous and crystalline samples with the same chemical composition (Ni50Ti50) are paramagnetic. The ferromagnetism is clarified by the existence of such regions of low atomic density.

MM 53.3 Thu 10:45 TC 010

Metallic nanoglasses from nanoparticle consolidation: A computational study — •Omar Adjaoud and Karsten Albe — Technische Universität Darmstadt, Fachbereich Material- und Geowissenschaften, Fachgebiet Materialmodellierung, Otto-Berndt-Str. 3, D-64287 Darmstadt, Germany

Metallic nanoglassses are amorphous materials with an inhomogeneous microstructure, which can be produced by consolidating nanometer-sized glassy spheres and consist of glassy grains connected by glass-glass interfaces. Experiments [1,2] and simulations [3,4] have revealed that glass-glass interfaces are chemically and topologically different from the grain intererior, but the influence of the consolidation process on the microstructure is still under debate. In this contribution, we present molecular dynamics simulations of the consolidation process of nanometer-sized metallic glassy spheres. Our results reveal that during cold compaction most of the glassy spheres deform by homogeneous plastic flow, while in some glassy spheres strain localization occurs. For all studied materials, the porosity is typically closed if the hydrostatic pressure exceeds 4 GPa. Structural analysis shows that the width of the resulting interfaces is significantly larger than in atomistic models based on planar interfaces. Moreover, structural changes occur not only in the interfaces but also in the glassy regions.

1. J. Jing *et al.*, J. Non-Cryst. Solids **113**, 167-170 (1989). 2. J.X. Fang *et al.*, Nano Lett. **12**, 458-463 (2012) . 3. Y. Ritter *et al.*, Acta Mat. **59**, 6588-6593 (2011) . 4. O. Adjaoud *et al.*, Acta Mat. **113**, 284-292 (2016).

MM 53.4 Thu 11:00 TC 010

Consolidation of amorphous powder by thermoplastic forming and subsequent mechanical testing — •Benedikt Bochtler[1], Moritz Stolpe[1,2], Benedikt Reiplinger[1], and Ralf Busch[1] — [1]Lehrstuhl für Metallische Werkstoffe, Universität des Saarlandes, Saarbrücken, Germany — [2]Heraeus Deutschland GmbH & Co. KG, Hanau, Germany

Bulk metallic glasses combine extraordinary strength with a large elastic limit, making them interesting for industrial applications. However, the casting of parts is complicated by the high cooling rates that are necessary. Alternatively, the production and subsequent consolidation of amorphous powder can decouple the production of an amorphous pre-material from the forming of the final part.

Here, amorphous powder of the commercially available Zr-based glass-forming alloy AMZ4 (Zr59.3Cu28.8Al10.4Nb1.5) is consolidated by thermoplastic forming (TPF), where the glassy powder is processed in the supercooled liquid state. Various time and temperature protocols are tested and evaluated regarding the powder compaction and the conservation of the amorphous structure. Compact and amorphous samples are obtained and are subsequently tested by three-point beam bending. The results show that the consolidated samples are still outperformed by as-cast bulk material in bending, however reach the hardness of bulk material. The experimental observations in combination with isothermal crystallization times and viscosity measurements allow to determine a generic TPF processing window that can be used as a tool to assess the thermoplastic formability of different alloys.

MM 53.5 Thu 11:15 TC 010

Synthesis, analysis and deformation of co-sputtered multi-layers of amorphous CuZr and nanocrystalline Cu — •Farnaz Abdollahzadeh Davani, Sven Hilke, Martin Peterlechner, and Gerhard Wilde — Materials Physics, Münster,Germany

Metallic glasses are of scientific and technical interest due to their high strength and hardness. Upon deformation, it is expected that soft spots deform locally, finally leading to localized shear in so-called shear bands. In this work, multi-layers of amorphous CuZr and nanocrystalline Cu have been prepared by magnetron co-sputtering of pure Zr and Cu. The as processed structures were analyzed using scanning electron microscopy and transmission electron microscopy. Upon deformation of the layered system, the deformation can be analyzed in the crystalline and amorphous regions. The processing and the deformation are discussed.