MM 36: Liquid and Amorphous Materials I

Time: Wednesday 11:45–13:00 Location: C 243

MM 36.1 Wed 11:45 C 243

Influence of SRO and MRO on the plastic deformation behavior of amorphous metals — •Valeria Lemkova[1,2], Florian Spath[1], Pia Weihing[1], Tobias Thielen[1], Christian Motz[1], Florian Schäfer[1], and Ralf Busch[2] — [1]Materials Science and Methods, Saarland University Campus D2 3, 66123 Saarbruecken, Germany — [2]Metallic Materials, Saarland University Campus C6 4, 66123 Saarbruecken, Germany

The plastic deformation behavior of amorphous metals is not yet fully understood. In particular, shear transformation zones (STZ) are at the center of the discussion. In order to better understand and characterize them, nanoindentation was used to determine the so-called pop-in behavior as well as the strain rate sensitivity (SRS). The SRS provides information on the interaction of the STZ and shear band formation, while the pop-ins are directly related to STZ formation, i.e., the plastic deformation behavior. Strain rate tests were carried out on different amorphous metals, in particular Zr-based (ZrCuNiAlTi) and Ti-based (TiZrCuSAl), with different short range (SRO) and medium range order (MRO) determined via scattering experiments. In the results the correlation between SRO / MRO and the plastic deformation behavior is evaluated and discussed.

MM 36.2 Wed 12:00 C 243

crack-healing mechanisms in high entropy alloys under ion irradiation — •qi xu, daniel sopu, and jürgen eckert — Erich Schmid Institute of Materials Science, Austrian Academy of Sciences, Jahnstraße 12, Leoben A-8700, Austria

High entropy alloys (HEAs) are potential candidate for advanced nuclear structural materials due to the outstanding mechanical properties and irradiation resistance in extreme conditions. However, microcracks, a common material damage, are introduced during the preparation and service processes, resulting in weakened structural integrity and irradiation resistance. In this work, an atomistic investigation of crack healing mechanisms in FeCoCrNiAl0.5 HEA under ion irradiation is provided by molecular dynamics (MD) simulations. Quantitative analysis of the point defect generation and recombination during the process of overlapping collision cascades are implemented to assess the irradiation response of cracked HEA. The interstitial defects generated in the core of the cascade during the first collision event diffuse to the crack surface, resulting in crack-healing during subsequent recrystallization. Additionally, the corresponding vacancies precipitate and form large-size vacancy clusters that generate stacking faults and complex dislocation networks distributed around the position of the healed crack. With increasing the number of overlapping cascades, the defects recombination rate increases and the phase stability is further improved. The crack healing engineering in HEA under ion irradiation could pave the way towards designing advanced nuclear materials.

MM 36.3 Wed 12:15 C 243

Influence of structural relaxation and composition on corrosion properties of Zr-based bulk metallic glass formers — •Benedikt Schmidt[1], Maximilian Frey[1], Florian Schäfer[2], Christian Motz[2], and Ralf Busch[1] — [1]Chair of Metallic Materials, Saarland University, Campus C6.3, 66123 Saarbrücken, Germany — [2]Chair of Materials Science and Methods, Saarland University, Campus D2.3, 66123 Saarbrücken, Germany

Bulk metallic glasses (BMGs) exhibit remarkable properties compared to crystalline alloys. They can surpass the strength of steels while also offering processability similar to polymers. Due to their amorphous structure and the resulting lack of grain boundaries, extensive attention has been directed toward the corrosion properties of these alloy systems. While previous studies have predominately focused on the comparison of the crystalline and amorphous state, the influence of structural relaxation of the glass remains poorly investigated. Through systematic sub-Tg annealing of a Zr-based BMG, we create samples with different fictive temperatures. Electrochemical analysis is performed via potentiodynamic polarization using a sodium chloride solution. We observe a consistent stability in the pitting potential, coupled with a shift of the free corrosion potential towards a more noble direction. Regarding a broader field of Zr-based systems, their corrosion mechanism is found to be mainly governed by selective corrosion as in case of the dezincification of brass. Notably, nickel emerges as a significantly influencing element in corrosion inhibition within these systems.

MM 36.4 Wed 12:30 C 243

Ni-Nb-P-based bulk glass-forming alloys: Superior material properties combined in one alloy family — •Lucas Ruschel and Ralf Busch — Chair of Metallic Materials, Saarland University, Saarbrücken 66123, Germany

Ni-Nb-based bulk glass-forming alloys are among the most promising amorphous metals for industrial applications due to their incomparable combination of strength, hardness, elasticity and plasticity. However, the main drawback is the limited glass-forming ability (GFA), narrowing the field of application to solely small components. A successful approach in alloy development is so-called minor alloying, where metallic glasses with improved properties and enhanced GFA are produced, if the proper minor alloying element is chosen for the respective base alloy. Here, minor additions of P to the binary Ni-Nb system increase the GFA up to 4 mm across a broad bulk glass forming region, culminating in a record value of 5 mm, which surpasses the binary $Ni_{62}Nb_{38}$ alloy by 150 %. Moreover, the primary precipitating phase, playing a crucial role for glass formation, is determined by container-less electrostatic levitation in-situ high-energy X-ray diffraction experiments. The mechanical properties of the new alloys are characterized in uniaxial compression tests and Vickers hardness measurements, showing a high engineering yield strength of 3 GPa, an extended plastic regime up to 10 % strain to failure and an increase of the hardness to a maximum value of 1000 HV5. Additionally, calorimetric measurements reveal an extended supercooled liquid region up to 69 K, permitting thermoplastic forming of amorphous feedstock material.

MM 36.5 Wed 12:45 C 243

Thermoplastic-patterned Ni-free Ti-based bulk metallic glass for biomedical research and its processing tolerance — Fei-Fan Cai[1,2], Andreu Blanquer[3], Miguel Brito Costa[4], Lukas Schweiger[1], Baran Sarac[2], A. Lindsay Greer[4], Jan Schroers[5], Christian Teichert[1], Carme Nogues[3], •Florian Spieckermann[1], and Jürgen Eckert[1,2] — [1]Montanuniversität Leoben, Austria — [2]Austrian Academy of Sciences, Austria — [3]Universitat Autonoma de Barcelona, Spain — [4]University of Cambridge, UK — [5]Yale University, USA

The advantageous mechanical properties and exceptional biocompatibility of Ni-free Ti-based bulk metallic glasses (BMGs) make them promising materials for biomedical applications. The glassy nature of BMGs allows them to be shaped and patterned via thermoplastic forming (TPF). The first part of this talk demonstrates the versatility of the TPF technique on Ti40Zr10Cu34Pd14Sn2 BMGs to create highly ordered patterns in micro- and nano-scales and a hierarchical structure integrating both patterns on one surface. The hierarchical structure fabricated by a two-step TPF process integrates 400 nm diameter hexagonal close-packed protrusions on 2.5 *2.5 μm^2 square protuberances and retains the beneficial mechanical properties of the as-cast materials. The second part of this talk focuses on the biocompatibility of Ti40Zr10Cu34Pd14Sn2 BMGs with four surface topographies (flat, micro-patterned, nano-patterned, and hierarchical-structured surfaces) using Saos-2 cell lines.