Characterization of oxide layers developed on ZrCuAl-based bulk metallic glasses during gaseous thermochemical treatment

Haratian, Saber; Villa, Matteo; Grumsen, Flemming Bjerg; Christiansen, Thomas Lundin; Somers, Marcel A. J.

Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

ISMANAM

Roma, 2-6 July 2018

25TH INTERNATIONAL SYMPOSIUM ON METASTABLE, AMORPHOUS AND NANOSTRUCTURED MATERIALS

nM2 Nanostructured Magnetic Materials

Science is Scool Cultural Association

PROGRAMME

MONDAY 2 July

08^{00}	Registration
09^{30}	Conference Opening
10^{00}	**PLENARY – Structure modulation and nanocrystallization of metallic glasses: how to tune mechanical properties.** Jürgen Eckert, Austrian Academy of Science & Montanuniversitat Leoben, Austria *Auditorium* **Chair**: To be defined
11^{00}	Coffee Break

	Parallel Session 1 *Auditorium*	Parallel Session 2 *Accademia*	Parallel Session 3 *Taurini*	Parallel Session 4 *Caudini*
	Metallic Glasses I **Chair**: To be defined	Nanostructured Materials I **Chair**: To be defined	Advanced Preparation and Processing I **Chair**: To be defined	Crystallization processes I **Chair**: To be defined
11^{30} 11^{45}	**[ID-99] (Invited)** Origin of fragility and the onset of cooperative dynamics in liquids.	**[ID-423] (Invited)** Stability and deformation behaviour of nanocrystalline high entropy alloys.	**[ID-382] (Invited)** Rapid solidification of $AlSi_{10}Mg$ + Cu mixed powders by single track laser melting and melt spinning.	**[ID-52] (Invited)** Tailoring nanocrystallization to break the speed limit of phase-change memory.
12^{00}	**[ID-98]** Corrosion and impedance behaviour of $Zr_{42}Cu_{50}Ag_8$ bulk metallic glass in artificial physiological solutions.	**[ID-100]** Mechanical properties of nanostructured materials embedded with nanotwins.	**[ID-421]** Al-Si-Ni-Cr-Fe alloy prepared by selective laser melting: microstructure and mechanical properties.	**[ID-332]** Influence of citrate and other small dicarboxylic acids on hydroxyapatite nanocrystal nucleation, growth and surface properties.
12^{15}	**[ID-133]** Nitrogen plasma immersion ion implantation treatment enhances the corrosion resistance, blood coagulation, and cell response of Zr-based bulk metallic glass for implant applications.	**[ID-128]** Interface-modulated strengthening ability of nanoscale Cu/Au multilayers.	**[ID-422]** Mechanical alloying and spark plasma sintering of nanostructured CuCrFeTiMn(Ni) high-entropy alloys.	**[ID-282]** Crystallization of Cu-Zr thin film metallic glass via femtosecond laser heating.
12^{30}	**[ID-152]** Characterization of oxide layers developed on ZrCuAl-based bulk metallic glasses during gaseous thermochemical treatment.	**[ID-174]** Enhancing the wettability of nano-scale Cu thin film on ZnO substrate by gas additives: A density-functional study.	**[ID-385]** Processes involved during nanostructured material production by pulsed laser ablation in liquid.	**[ID-330]** Controlling the Curie temperature in amorphous glass coated microwires by heat treatment
12^{45}	**[ID-163]** Atomic structure and devitrification of Ca-based metallic glasses.	**[ID-41]** Tribological and corrosion property of Fe-based metallic glass nanocomposite coatings synthesized by thermal spraying.	**[ID-149]** Cooling strategies for droplet solidification of glass forming alloys.	. **[ID-119]** Creep testing of woven fabric flax-polypropylene composite using digital correlation image (DIC).

ID-152

Characterization of oxide layers developed on ZrCuAl-based bulk metallic glasses during gaseous thermochemical treatment

S. Haratian, M. Villa, F.B. Grumsen, T.L. Christiansen, M.A.J. Somers

Technical University of Denmark (DTU)

The current study addresses an investigation of low-temperature oxidizing treatment ($<T_g$) of ZrCuAl- based BMGs, which have been monitored by thermogravimetry. The thermochemical treatment was applied in two different gaseous atmospheric conditions providing low and high oxygen partial pressures. The microstructural evolution and surface morphology of the oxidation zone developing during the treatment of ZrCuAl-based BMGs were investigated utilizing X-ray diffraction and advanced electron microscopy techniques. The oxygen-containing case formed in the metallic glassy substrate was further investigated with in-situ ion beam channeling. The results demonstrate that after conducting the oxidizing treatment in the atmosphere containing high oxygen partial pressure, an outer oxidation layer and an inner oxide zone develop. In the gas with a low oxygen partial pressure only the inner oxidation zone results. Interestingly, four oxide regions with different chemical composition, which mainly consist of ZrO_2 (with two different lattice structures; tetragonal and monoclinic) and Al_2O_3 are present in the inner layer where the oxygen is distributed through the substrate. Furthermore, the outer oxide layer is enriched in copper which has diffused out of the BMG. Cracks have developed adjacent to the surface, which is ascribed to the stresses resulting from oxide formation in the inner oxidation zone. Some of the cracks are filled out with copper. This phenomenon was also observed in Ag-containing BMG, where both copper and silver enrich at the surface.