MM 20 Amorphous and Liquid Materials I

Time: Tuesday 14:45–16:00 Room: IFW D

MM 20.1 Tue 14:45 IFW D

Soft-Particle-Reinforced Bulk Metallic Glass Composites with High Ductility — •Marco E. Siegrist and Jörg F. Löffler — Laboratory of Metal Physics and Technology, Department of Materials, Swiss Federal Institute of Technology (ETH) Zürich, CH-8903 Zürich, Switzerland

We introduced graphite particles into an amorphous $Zr_{52.5}Cu_{17.9}Al_{10}Ni_{14.6}Ti_5$ (Vit 105) matrix with the aim of increasing plasticity and improving the wear and friction properties of monolithic metallic glass. The graphite particle size was varied from 25-75 microns and the reinforcement content from 5-30 vol%. By adjusting the processing parameters part of the graphite can be transformed into ZrC, which allows a systematic change in mechanical properties. This contribution describes the thermophysical and mechanical properties of these graphite/ZrC Bulk Metallic Glass matrix composites. The crystallization sequence of the matrix was studied using differential scanning calorimetry, and the amorphous structure was confirmed by x-ray diffraction. The effect of varying the particle size and carbide content on composite hardness, fracture strength and ductility was investigated. We found that graphite causes a decrease in hardness, whereas carbide formation leads to an increase in hardness compared to the monolithic matrix material. The best mechanical properties were observed with large particles at low volume fractions of graphite, where 18.5% plastic deformation combined with a fracture strength of 1.85 GPa was achieved. The effect of particle reinforcement on fracture behavior was studied using high-resolution scanning electron microscopy.

MM 20.2 Tue 15:00 IFW D

Is $Cu_{47}Ti_{33}Zr_{11}Ni_8Si_1$ a bulk glass former ? — •Shankar Venkataraman[1], Mihai Stoica[2], Sergio Scudino[1], Ki Buem Kim[1], Ludwig Schultz[3], and Jürgen Eckert[1,3] — [1]FG Physikalische Metallkunde, FB 11, Material- und Geowissenschaften, Technische Universität Darmstadt, Petersenstraße 23, D-64287 Darmstadt, Germany — [2]Institut National Polytechnique de Grenoble, ENSEEG, LTPCM, 1130 rue de la Piscine, PO Box 75, 38402 St.Martin d'Hères campus, Grenoble, France — [3]Institut für Metallische Werkstoffe, Leibniz-Institut für Festkörper-und Werkstoffforschung, Helmholtzstraße 20, D- 01069 Dresden, Germany

The microstructures of $Cu_{47}Ti_{33}Zr_{11}Ni_8Si_1$ ribbons and rods synthesized by melt spinning and copper mold casting have been investigated using transmission electron microscopy (TEM) as well as high-resolution TEM (HRTEM). Though a fully amorphous microstructure is observed for the as-spun ribbons, a fine nanocrystalline microstructure is observed for the rods suggesting that the bulk glass forming-ability of this alloy has been previously overestimated. This work attempts to address the reasons for the lack of a fully glassy phase in the bulk $Cu_{47}Ti_{33}Zr_{11}Ni_8Si_1$ alloy.The present study shall also show that the selection of a proper sample preaparation method is also crucial in observing an artifact free microstructure under the TEM. This work was supported by the German Research Foundation (Grant no. Ec 111/12) as well as by the European Union within the framework of the Research Training Network on "ductile bulk metallic glass composites" (MRTN-CT-2003-504692).

MM 20.3 Tue 15:15 IFW D

The Origin Of Glass Forming Ability in Zr-Ti-Ni-Cu-Be Bulk Glasses — •S. Mechler, M.-P. Macht, and N. Wanderka — Hahn-Meitner Institut-Berlin, Glienicker Str. 100, 14109 Berlin

$Zr_{46.8}Ti_{8.2}Ni_{10}Cu_{7.5}Be_{27.5}$(V4) is one of the best metallic glass formers known so far. This glass exhibits an extended supercooled liquid region. At temperatures above the glass transition it can form a quasicrystalline phase. The quasicrystals are found to be mainly depleted in Be and enriched in Ti. A series of alloys based on V4 composition with variation of Be content (from 0 to 35 at.%) were produced in order to investigate the influence of the Be on the glass forming ability (GFA). The Be-free glass shows only a narrow temperature region between glass transition and crystallization. After heat treatment around the glass temperature it shows a polymorphous transition from the amorphous to the quasicrystallline state. Higher Be contents result in better GFA. The GFA has its maximum for the alloys with Be contents between 25 at.% and 27.5 at.%. During annealing of these alloys the formation of the quasicrystalline phase is retarded. Upon heating in DSC the crystallization is shifted to higher temperatures, leading to the observed large temperature range between glass transition and crystallization of V4 glass. Investigations of the short range order in the glasses with different Be content indicated correlation between Icoshedral Short Range Order (ISRO) and Be content, with a highest degree of ISRO in the Be-free alloy. It is concluded that the ISRO is the key parameter in understanding the bulk glass forming ability and the extended stability of the supercooled liquid in the Zr-Ti-Ni-Cu-Be system.

MM 20.4 Tue 15:30 IFW D

Glass forming ability and thermal behavior of Ni-based alloys — •Konrad Eymann, Uta Kühn, Helmut Hermann, Norbert Mattern, and Ludwig Schultz — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

The Ni-based alloys Ni-Zr-Al-Y [1], Ni-Nb-Ti-Zr-Co-Cu [2], Ni-Nb-Sn [3], and Ni-Cu-Ti-Zr-Al [4] were evaluated concerning their glass forming ability (GFA) by preparing ribbons and bulk specimens in form of cylindrical rods with diameters of 2 or 3 mm. The samples were prepared by melt spinning technique as well as by copper mold casting. The microstructure of the ribbons and rods were characterized using XRD measurements and TEM. The thermal behavior was measured by DSC. For example the glass transition temperature was used for the calculation of the parameter gamma [5] to evaluate the Ni-alloy with the best theoretical GFA. The gamma-parameter was compared to the actual microstructure of the bulk samples. The alloy with the highest GFA was found to be Ni-Cu-Ti-Zr-Al. To enhance the GFA of this alloy the composition was modified by adding further elements. The elements were chosen by computer simulations using the Bernal's model of simple liquids generalized for multicomponent metallic systems, which finally lead to a liquid with optimized density.

[1] Yi, S. et al., Mater. Lett. 48, 258 (2001). [2] Zhang, T. et al., Mater. Trans. 43, 4, 708 (2002). [3] Choi-Yim, H. et al., Appl. Phys. Lett. 82, 7, 1030 (2003). [4] Xu, D. et al., Acta Mater. 52, 3493 (2004). [5] Lu, Z.P. et al., Acta Mater. 50, 3501-3512 (2002).

MM 20.5 Tue 15:45 IFW D

Microstructure controlled magnetic properties of the Zr53Co23,5Al23,5 bulk metallic glasses — •Ahmed Shariq[1], Talaat Al-Kassab[1], Reiner Kirchheim[1], Dmitrij Bogdanov[2], Konrad Samwer[2], Qiang Jianbing[3], and Chuang Dong[4] — [1]Institut für Materialphysik, Friedrich Hund platz 1, D 37077, Göttingen, Germany — [2]I. Physikalisches Institut, Friedrich Hund platz 1, D 37077, Göttingen, Germany — [3]Department of Materials Engineering, Dalian University of Technology, Dalian 116024, China — [4]State Key Laboratory of Materials Modification, Dalian University of technology, Dalian 116024, China

The unique set of properties offered by the amorphous alloys triggered intensive microstructural investigations in the last few years. The new amorphous alloys have much wider supercooled liquid region defined as the difference between crystallisation and glass transition temperatures and require relatively slower cooling rates. Zr53Co23,5Al23,5 has already been reported as a good glass forming alloy. In the present contribution, the magnetic properties of the bulk metallic glass of the above said system are shown. The bulk sample shows very soft ferromagnetic properties. The crystallization in this system occurs in two steps. With the introduction of the crystalline phase the magnetic properties vary considerably and the bulk sample also shows some magnetic anisotropy. The kinetics of the formation of these crystalline phases as a function of temperature and subsequent effect on the magnetic properties will be discussed.