MM 61: Liquid & Amorphous Metals I

Time: Thursday 15:45–17:00 Location: H26

MM 61.1 Thu 15:45 H26

Density and viscosity of Cr-Fe-Ni ternary liquid alloys — •Hidekazu Kobatake and Juergen Brillo — Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft- und Raumfahrt, Köln, Germany

Materials of practical relevance, such as Fe-based alloys or stainless steels are mainly ternary combinations of Cr, Fe and Ni. Density and viscosity of these liquid metals are required to simulate the buoyancy forced convection in a liquid during the welding and casting process. Especially, density is required as input parameter for the calculation of other thermophysical properties from the primary measurement data. In this study, the density was measured using electromagnetic levitation as a container-less technique. The shadowgraph of the sample was captured by digital CCD camera and its volume was calculated to by an image processing algorithm to determine the density. In the measured concentration range, the excess volume is positive. The experimentally obtained densities of the ternary system agree well with those calculated according to a thermodynamic mixing rule taking into account contributions from the binary margin systems only. Viscosities, η have been measured by means of a high-temperature oscillating cup viscometer. A cylindrical cup which contains the liquid sample is suspended by a torsion wire and is oscillated around its vertical axis. η was then obtained from the decrement of the oscillation. In the investigated compositional range of the Cr-Ni-Fe system, η as a function of temperature can be described by an Arrhenius law. Isothermal viscosities will be compared to existing thermodynamic models.

MM 61.2 Thu 16:00 H26

Phase separation in liquid and amorphous metallic alloys — •Norbert Mattern[1], Junhee Han[1], Ulla Vainio[2], Ahmed Shariq[3], Pradeep Konda Gokuldoss[4], Dierk Raabe[4], and Jürgen Eckert[1,5] — [1]IFW Dresden, Institute for Complex Materials — [2]Hasylab at Desy, Hamburg — [3]FhG Center Nanoelectronic Technology, Dresden — [4]MPI für Eisenforschung,Düsseldorf — [5]TU Dresden,Institute of Materials Science

Phase-separated glasses are well known for oxide glasses and polymers. In the last years two-phase glasses were successfully prepared in different metallic alloy systems by rapid quenching from the melt. We report recent results on the influence of composition and casting conditions on the phase separation and the structure formation of glass forming metallic alloys Zr-M-Al-Gd (M =Cu,Co,). The decomposition in such alloys is a consequence of the large positive enthalpy of mixing between Zr and Gd (Hmix= +9 kJ/mole). We will show that early stages of spinodal decomposition can be obtained if the critical temperature of liquid-liquid phase separation is near to the glass transition temperature. Evidence of formation of Gd-enriched clusters by a spinodal mechanism is obtained by small-angle X-ray scattering and atom probe tomography.

MM 61.3 Thu 16:15 H26

Phase separation in ternary Co-Gd-Ti liquids — •Junhee Han[1], Norbert Mattern[1], Dirk Holland-Moritz[2], Jozef Bednarcik[3], Ivan Kaban[1], Rafal Nowak[4], Natalia Sobczak[4], and Jürgen Eckert[1] — [1]IFW-Dresden, Dresden, Germany — [2]Institut für Materialphysik im Weltraum, DLR, Köln, Germany — [3]HASYLAB, DESY, Hamburg, Germany — [4]Center for High Temperature Studies, Foundry Research Institute, Krakow, Poland

Phase equilibrium and solidification behavior of ternary Co-Gd-Ti (Co $\leq$ 35 at. %) alloys has been investigated by thermal analysis (DSC) and microstructural characterization of cast alloys (SEM/EDX). The phase equilibria with the liquid phase were studied in situ for two alloys $Co_{30}Gd_{35}Ti_{35}$ and $Co_{30}Gd_{50}Ti_{20}$ by combining electrostatic levitation of the melt with high-energy synchrotron X-ray diffraction at elevated temperature. For $Co_{30}Gd_{35}Ti_{35}$ we observe two diffuse diffraction maxima (T = 1600 - 1700 K) giving direct evidence of liquid-liquid phase separation. The maxima positions exhibit a temperature dependent shift due to the change in chemical compositions with temperature in accordance with the binodal line. For $Co_{30}Gd_{50}Ti_{20}$, no indication of phase separation is detected. Coarsened microstructures typically for phase separated liquids are observed in cast alloys $Co_{30}Gd_{35}Ti_{35}$, $Co_{25}Gd_{37.5}Ti_{37.5}$, $Co_{10}Gd_{45}Ti_{45}$ and $Co_{30}Gd_{20}Ti_{50}$. Our findings suggest that the stable miscibility gap of the binary Gd-Ti extends into the ternary Gd-Ti-Co system (up to Co < 35 at. %). Thermodynamic calculations of the ternary Co-Gd-Ti by the CALPHAD method are in a good agreement with experimental findings.

MM 61.4 Thu 16:30 H26

Crystallisation and glass transition of a AuSi based metallic glass investigated by chip based ultra fast scanning calorimetry — •Joachim Bokeloh, Jonas Bünz, and Gerhard Wilde — Institut für Materialphysik, WWU Münster

The glass transition as well as the crystallization of metallic glasses have been extensively studied in the past. These investigations are limited by two experimental issues. For one, the complex relationship between intrinsic properties of the material and its time-temperature history renders the state of cast samples somewhat ambiguous. Secondly, conventional laboratory equipment is incapable of exploring the broad dynamic range that is of interest in the case of metallic glasses.

We present here measurements of a AuSi based metallic glass by chip-based ultra fast scanning calorimetry (50K/s - 10 000 Ks). The high heating and cooling rates allow for a highly controlled and repeatable in-situ vitrification of a glassy sample, investigation of the glass transition during heating as well as cooling at various rates and an in-depth analysis of the crystallization behaviour when cooled down from the melt, as compared to when heated up from the glassy state.

MM 61.5 Thu 16:45 H26

Reactive wetting and solder spreading — •André Wedi and Guido Schmitz — Institut für Materialphysik, Westf. Wilhelms-Universität, Wilhelm-Klemm-Strasse 10, 48149 Münster, Germany

Wetting is an important pre-requisite of a reliable solder connection. However, it is only an indirect measure for the important specific energy of the reactive interface between solder and base metallization of Cu and Ni. In order to quantify this energy, we measured wetting angles of solder drops as well as surface tension of SnPb and SnBi solders under systematic variation of composition and gaseous flux at different reflow temperatures by the sessile drop method. Remarkably, the tension between solder and flux and the wetting angle reveal characteristic dependence on solder composition. From the two independent data sets, the specific energy of the reactive interface, the adhesion tension, is evaluated. In detail, the adhesion energy reveals distinguished plateaus which are related to different reaction products in contact to the solder. Using a dedicated geometry [1], which enables investigation of the wetting kinetics, spreading speed and maximum spreading distance are measured. We demonstrate correlations between the latter kinetic parameters and the phase structure in the reaction zone.

[1] F.M. Hosking et al, Journal of Electronic Materials, Vol. 25, No. 7, 1996.