MM 9: Topical Session Bulk Nanostrucured Materials II - Processing

Time: Monday 11:45–13:00 Location: H 0107

Topical Talk MM 9.1 Mon 11:45 H 0107

Tailoring and grading materials properties by Accumulative Roll Bonding — •Heinz Werner Höppel and Mathias Göken — Dept. of Materials Science and Engineering, Institute I, University Erlangen-Nürnberg, 91058 Erlangen, Germany

Accumulative roll bonding (ARB) is a very promising and also prominent process to produce ultrafine-grained sheet materials in larger quantities. During the last decade, strong progress was made in processing technology combined with a much deeper understanding of the microstructural evolution during ARB-processing. Besides this well-known conventional route of ARB-processing, new concepts have been derived to produce multiphase, tailored or graded sheet materials with promising properties. By an intelligent ARB-processing 3D-architectured multiphase materials can be achieved aiming for locally tailored materials properties. It is shown, that the materials properties can be tailored locally by an adopted powder spraying process via the ARB process. Moreover, by using an appropiate post ARB-heat treatment, this technique can aslo be used to strengthen the sheet material by the formation of intermatallic phases in the sheet. In the talk, microstructural and mechanical properties with respect to the processing parameters will be discussed in detail.

MM 9.2 Mon 12:15 H 0107

Severe plastic deformation of NiAl by high pressure torsion — •David Geist, Christoph Gammer, Hans-Peter Karnthaler, and Christian Rentenberger — Universitys of Vienna, Physics of Nanostructured Materials, Boltzmanng. 5, 1090 Wien, Austria

Severe plastic deformation is an important process to render bulk materials nanostructured. In this work, the B2-ordered intermetallic compound NiAl is subjected to a high pressure torsion deformation at room temperature. The structure of NiAl after different amounts of shear deformation is studied using light microscopy, scanning and transmission electron microscopy. Plan view and cross-section samples are investigated for a local analysis of the occurring micro- and nanostructures. It is shown that high pressure torsion deformation of NiAl leads to different fragmented structures that are inhomogeneously distributed in the cross-section samples. In some regions, ultra-fine grained and nanocrystalline structures are observed. Contrary to B2 ordered FeAl [1], no indications of deformation-induced disordering were encountered. This difference in disordering behaviour is attributed to the dissociation modes of the glide dislocations with and without antiphase boundaries in FeAl and NiAl, respectively. It is shown that high pressure torsion can be used to severely refine the structure even in the case of a brittle compound like NiAl.

[1] C. Gammer et al. (2011) Scripta Materialia 65 (1) 57. The authors thank Dr. Sergiy Divinski, Institute for Materials Physics, University of Munster, for the kind provision of NiAl samples and acknowledge support by the Austrian Science Fund (FWF):[P22440, S10403]

MM 9.3 Mon 12:30 H 0107

Solid state amorphization of bulk Co_3Ti using high pressure torsion — Christoph Gammer, David Geist, Christian Rentenberger, and •Hans-Peter Karnthaler — University of Vienna, Physics of Nanostructured Materials, Boltzmanngasse 5, 1090 Wien, Austria

Amorphous structures can be achieved by a solid state transformation of the crystalline structure using severe plastic deformation. This has been proven to be successful by applying high pressure torsion (HPT) deformation in the case of $L1_2$ ordered Zr_3Al [1]. In addition, a cyclic transformation from crystalline to amorphous and back to a crystalline phase was reported to occur in Co_3Ti upon high-energy ball milling of a mixture of elemental powders [2]. In the present study bulk material of intermetallic Co_3Ti is transformed locally to an amorphous phase by HPT deformation. The deformation structures are analysed on different length scales using both scanning and transmission electron microscopy (TEM) methods. To avoid crystallization during preparation, the TEM samples were prepared electrochemically. They show amorphous bands that contain a debris structure of small grains (~ 5 nm) as in Zr_3Al. In addition, the presence of some large (~ 50 nm) defect free grains occurring in the amorphous bands indicate the reverse transition from an amorphous phase back to a crystalline one.

[1] D. Geist, C. Rentenberger, H. P. Karnthaler. Acta Mater. 59, 4578 (2011) [2] M. Sherif El-Eskandarany, K. Aoki, K. Sumiyama, K. Suzuki. Acta Mater. 50, 1113 (2002). This work was supported by the Austrian Science Fund (FWF): [P22440].

MM 9.4 Mon 12:45 H 0107

SPD processed ß-TiNb alloys for biomedical applications — •Ajit Panigrahi[1], Thomas Waitz[1], Erhard Schafler[1], Matthias Bönisch[2], Mariana Calin[2], Annett Gebert[2], Jürgen Eckert[2,3], Werner Skrotzki[4], and Michael Zehetbauer[1] — [1]Physics of Nanostructured Materials, Faculty of Physics, University of Vienna, Austria — [2]Institut für Komplexe Materialien, IFW Dresden, Germany — [3]Institut für Werkstoffwissenschaft, TU Dresden, Germany — [4]Institut für Strukturphysik, TU Dresden, Germany

The scientific goals of the recently established EU MC training network "BioTiNet" comprise the development of nanocrystalline and amorphous ß-Ti alloys for medical implants. Using methods of severe plastic deformation, it is the aim to process novel materials that show a tailored combination of high strength, considerable ductility, biocompatibility and low Young's modulus. A low value of Young's modulus of the ß-Ti-Nb alloys close to that of bone is a prerequisite for applications as materials for prosthesis minimizing stress shielding effects. ß-Ti-Nb based alloys including "gum metals" are of special interest. These materials also offer the possibility to accommodate elastic strains via superelasticity occurring by a martensitic phase transformation. This work reports on first results obtained by mechanical investigations of ß-Ti-Nb alloys of selected compositions which have been processed by HPT and ARB. X-ray profile analyses using synchrotron radiation is used to analyse the mechanisms of plastic deformation where dislocations seem to play only a minor role. Work supported within the EU Programme FP7/2007-13 under grant agreement No. 264635 (BioTiNet-ITN)