MM 2 Symposium Severe Plastic Deformation I

Time: Monday 10:15–12:45 Room: IFW A

Keynote Talk

MM 2.1 Mon 10:15 IFW A

Accumulative Roll-Bonding of Aluminium and Aluminium Alloys — •Irena Topic, Christine Klösters, Heinz-Werner Höppel, and Mathias Göken — Friedrich-Alexander-University Erlangen-Nuremberg, Department of Materials Science and Engineering, Institute of General Material Properties (WW1), Martensstraße 5, 91058 Erlangen, Germany

The interest in ultrafine-grained (UFG) materials has increased strongly during the past decade due to their superior strength and ductility. One of the ways to obtain an UFG microstructure is by accumulative roll-bonding (ARB). This is a severe plastic deformation process capable of obtaining an average grain size below 1um. During the ARB process, the 1mm aluminium strips are wire brushed, stacked, rolled together with a thickness reduction of 50% and at the end halved. The whole process was repeated up to 12 times for technically pure aluminium and up to 10 times for the aluminium alloy AA6016. The biggest advantage of this process is that it can be adopted in the industry to produce large scale UFG metal sheets. Due to the significantly increased specific strength paired with a high ductility, UFG sheet metals processed by ARB have a strong potential for prospective engineering applications in the transportation industry. In order to qualify the ARB process for these purposes detailed investigations on the robustness of the process, mechanical properties and the microstructural evolution are being carried out.

Keynote Talk

MM 2.2 Mon 10:45 IFW A

Recent developments in optimization of mechanical properties of mechanically alloyed/ball milled nanostructured materials — •Jürgen Eckert, Sergio Scudino, and Shankar Venkataraman — Physical Metallurgy Division, Department of Materials and Geo Sciences, Darmstadt University of Technology, Petersenstr. 23, D-64287 Darmstadt, Germany

One of the areas of research on nanostructured materials that has received extensive study is their mechanical behavior. The great interest in the mechanical behavior of nanostructured materials originates from the unique mechanical properties observed and/or predicted when the critical length-scale of the microstructure/phases approaches the nanoscale. Such features include increased hardness and strength as well as the expectation of enhanced ductility, and perhaps even superplastic behavior at low homologous temperatures. While some of these observations and predictions have been verified, some have been found to be due to high porosity or other processing artefacts, and not inherent properties of the nanostructured materials. This presentation reviews recent developments in the development of mechanically alloyed/ball milled nanostructured metals and alloys and addresses the limitations to ductility in nanocrystalline materials. Examples of recent breakthroughs wherein both high strength and good ductility are observed will be presented and discussed in the light of possible functional and structural applications for nanostructured materials. This work was supported by the German Science Foundation (DFG).

Keynote Talk

MM 2.3 Mon 11:45 IFW A

New Routes to obtain Massive Nanostructured Materials — •Gerhard Wilde — Forschungszentrum Karlsruhe, Institute of Nanotechnology, P.O.B. 3640, 76021 Karlsruhe, Germany

Synthesizing massive nanocrystalline materials that are free from residual porosity and free from contaminations of the interior interfaces still presents a challenge to basic research as well as to application-related processing efforts. Severe plastic deformation (SPD) processes have frequently been applied to synthesize massive ultrafine-(submicron)-grained or disk-shaped nanostructured pure metals and alloys. New opportunities might be based on combining different non-equilibrium processing routes sequentially such that an initially metastable state is continuously energized and successively driven farer away from thermodynamic equilibrium. One example is given by plastically deforming metallic glasses. Another way to obtain specimens, e.g. of pure metals with extremely small average grain sizes and with quantities in the gram range is given by repeated cold-rolling and folding. The microstructure evolution as well as the limits of this technique in comparison to conventional SPD methods will be discussed. Additionally, sequentially combining different processing pathways that are based on continuous strain energy input present new routes for nanostructure formation. The available permutations offer a wide range of options for tailoring the microstructure and the shape and quantity of the product nanostructure and, at the same time, present a wide field yet to be explored. The support of this work by the DFG is gratefully acknowledged.

MM 2.4 Mon 12:15 IFW A

Synthesis of nanostructured Al-Y-Fe using SPD processing — •Nancy Boucharat[1], Rainer Hebert[1,2], Harald Rösner[1], and Gerhard Wilde[1] — [1]Forschungszentrum Karlsruhe, Institute of Nanotechnology, P.O.B. 3640, 76021 Karlsruhe, Germany — [2]University of Wisconsin-Madison, Department of Materials Science and Engineering, Madison, WI 53706, USA

A common way to produce nanostructures from Al-rich glass-forming alloys is to apply low temperature isothermal treatments. However, plastic deformation can also induce crystallization in metallic glasses. Thus, deformation at large strains might present an alternative route for producing bulk nanostructures of adjustable grain size. We report here structural analyses of an Al-Y-Fe glass that has been subjected to high-pressure torsion straining at room temperature. The results show a remarkably high number density of Al-nanocrystals compared to the values obtained after annealing at low temperatures or after cold rolling at moderate strains, respectively. The nanocrystals appear to be distributed homogeneously throughout the sample without any evidence of strong coarsening. Moreover, the comparison between deformation-mediated nanocrystallization by applying either high pressure torsion straining or cold rolling is discussed with respect to the likely mechanisms underlying the nanocrystallization during deformation. These results form the basis for the development of advanced processing strategies for producing new nanostructures with high nanocrystal number densities giving rise to increased stability and improved performance of the nanoscale microstructure. Support by the DFG is gratefully acknowledged.

MM 2.5 Mon 12:30 IFW A

Downscaling the ECAP process — •Aikaterini Zi, Ralph J. Hellmig, and Yuri Estrin — Institut für Werkstoffkunde und Werkstofftechnik, Technische Universität Clausthal, Agricolastr. 6, 38678 Clausthal–Zellerfeld

Equal Channel Angular Pressing (ECAP) is a well–known severe plastic deformation method used to produce ultra–fine grained materials. The dimensions of ECAP specimens are usually in the centimetre range. Downscaling the ECAP process may be a viable option for producing high strength wires or fibres in the millimetre range. A multi channel die with channel diameter of 2 mm was used for that purpose. Microstructure investigations demonstrating significant grain refinement confirm the viability of this approach.