VIDEO ARTICLE

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High Efficiency of Renewable Energy Sources Through SPD Processing of Bulk Nanostructured Solids

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Abstract

Over the last two decades the processing method “Severe Plastic Deformation–SPD” has impressively demonstrated that nanostructured materials with superior mechanical properties can be produced “top-down” in bulk shape which cannot be achieved with traditional “bottom-up” methods. Now, the optimization of functional properties has been coming into the focus of the community’s research, not at least since the authors reached outstanding successes such as world-records in the figure-of-merit (ZT) of SPD-thermoelectrics, and in the reproducibility in the hydrogen storage of SPD-processed hydrogen storage materials. Recent investigations by the authors clearly suggest that a high density of SPD- induced lattice defects other than of classical grain boundaries can be equally or even more beneficial with respect to functional properties. For example, in case of thermoelectrics, SPD-induced dislocations and/or particular dislocation arrays seem to be most effective in increasing the ZT value. Also in case of soft magnetic materials, regular dislocation arrays from SPD which form low-angle zero-strain nanocrystal boundaries promise new low-coercivity and high-magnetostriction materials, while in case of hydrogen storage, thermally stable SPD-induced vacancy clusters seem to govern the formation / dissolution of the hydride phase. With the know-how to be obtained from systematic investigations, it should be possible to tailor specific defect structures on the nanoscale for optimum functional materials performances with very promising perspectives to practical applications.

Biography of Presenting Author

Michael Josef Zehetbauer was born 1951 in Vienna, Austria, and studied Physics at the University of Vienna. While holding a position as scientific assistant, he received his PhD degree concerning the "Effects of Short Range Order to the Strength of Alloys". As a young assistant professor he focused his research on the field of plasticity of materials, and was awarded the habilitation in 1992 for Solid State Physics. Five years later, within the Institute of Materials Physics of University of Vienna, he was appointed as Assoc. Univ. Professor. In 2007 he became the head of a new research group named "Physics of Nanostructured Materials" with more than 40 members, and directed it until his retirement in 2016. The scientific oeuvre of Prof. Michael Zehetbauer is mainly based on fundamental works in the plasticity of metals and of polymers. Besides new findings raising the importance of dislocation kinetics for the strength of semicrystalline polymers, he pioneered the stages IV and V of plastic deformation of crystalline materials, and created a physical model called "Zehetbauer's model" simulating the strengthening in solids in terms of statistical interactions of screw and edge dislocations, and deformation-induced vacancies. He was among the first scientists establishing the field of "Severe Plastic Deformation" (SPD), with emphasis on the role of hydrostatic pressure for both reaching high deformation strains as well as high densities of defects, especially vacancies. As of recent, M. Zehetbauer has been demonstrating the high potential of SPD induced defects for increasing the efficiency of functional materials, such as nanostructured thermoelectrics, hydrogen storage materials, and biodegradable implant materials. So far Michael Zehetbauer has published about 280 mostly peer-reviewed papers in high impact journals, which have been currently cited almost 7000 times in total, 9 of them more than 100 times, and 1 of them even more than 1000 times. Altogether, these citations sum to an h-factor of h=43. M. Zehetbauer has organized 10 international conferences, which included the publication of related proceedings, and has also edited the book "Bulk Nanostructured Materials" with 30 reviews of articles from world-renowned authors. He held Visiting Professorships at the Technical University Braunschweig, Germany, and at the Universities Strasbourg and Metz, France. He was assigned several international prizes, among them the Tammann Commemorative Medal of the German Materials Society, the Fray International Sustainability Award, and recently the UNESCO Medal for Nanoscience and Nanotechnology. He is a founding member of the International NanoSPD Steering Committee, and has been a member of the Board of the European Materials Research Society since 2005. Michael Zehetbauer is known for his passion for materials physics, which is also reflected by his teaching activities that include numerous oral and lab courses on materials physics. Thereby he has attracted so far 42 students who finished PhD and MSc works under his supervision.

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