Helmholtz-Zentrum Geesthacht
Zentrum für Material- und Küstenforschung
Max-Planck-Strasse 1, 21502 Geesthach

Institut für Werkstoffforschung

Materialwissenschaftliches Seminar 2011
Jeden 2. Donnerstags, 10 Uhr, Hörsaal, Gebäude 27, HZG, t

Institute of Materials Research

Materials Science Seminar 2011
Each 2nd Thursday, 10 a.m., Lecture Hall, Building 27, HZG,
Max-Planck-Strasse 1, 21502 Geesthacht

Datum / Date	Vortrag / Presentation	Gastgeber / Host:
1. Jahreshälfte / 1. Half Year2011		
07.04.	Thiago Ferreira da Conceição, HZG WZK	Dr. Wolfgang Dietzel
	"Corrosion protection of magnesium AZ31 alloy sheets by polymer coatings" The protection against corrosion of magnesium AZ31 alloy sheets offered by three different polymer coatings (PEI, PVDF and PAN) was investigated. The coatings were prepared using both the spin-coating and dip-coating method. The sheets had been pre-treated by either acid cleaning or by mechanical grinding in order to assess the influence of the substrate surface on the coating performance. For all three polymers the performance came off best on HF-treated substrates due to an acid-base interaction between polymer and the formed MgF2 layer at the interface. These interfacial reactions were further investigated, and in the case of PVDF it turned out that a self-healing mechanism occurred in the course of the corrosion process. Of the three polymer coatings, the PEI coating prepared by dip-coating on an HF-treated substrate offered the best corrosion protection, while the PVDF coatings had in particular a lower adhesion. The PAN coatings had the weakest performance but showed interesting properties with respect to potential biomedical applications.	
28.04.	Prof. František Chmelík, Department of Physics of Materials, Charles University Prague, Czech Republic	Prof. Karl Ulrich Kainer
	Exploring plastic deformation of metallic materials by the acoustic emission technique In determination of direct correlation between materials properties and parameters of testing environment, the non-destructive in-situ methods play a significant role as they correlate material parameters to those of the testing environment in real time. Among the tools emerging in the last decades, the acoustic emission technique belongs to the most powerful and reliable ones. The acoustic emission (AE) is a physical phenomenon, which stems from transient elastic waves, generated within a material due to sudden localized and irreversible structure changes. It responds to dislocation motion and twinning and therefore yields information on the dynamic processes involved in plastic deformation of metallic materials. Numerous studies have found a distinct correlation of the AE response with sample orientation, purity, grain	

	size, strain rate, temperature and the mode of testing (tension, compression). In all cases, deformation twinning and dislocation glide were found to be the major sources of AE. Most recently, it has been demonstrated that the AE response is a manifestation of intermittent character of crystalline plasticity. This finding opens new horizons in studying plastic deformation as a result of collective lattice defects motion, which occurs on different space and time gauges, from micro- to macro-scales.	
12.05.	Jan-Roman Pauls, HZG WTE	Prof. Thomas Klassen
	<u>Zero Emission Fossil Fuel Power Plants – Polymeric Membranes as a Key-Technology?</u> Carbon Capture and Storage Technologies (CCS) constitute one big challenge in the development of zero emission power plants. Membrane based processes have potential as a key-technology for CO_2 capture from flue gases. Commercially available polymeric materials, containing polyethylene oxide (PEO) have one of the best CO_2/N_2 selectivity combined with high permeation rates. Presence of water vapour can lead to changes in membrane separation behaviour of PEO structures. Studying these effects is very important due to the high water vapour content in flue gas. The presentation will give a short overview of different concepts regarding CO_2 separation from power plant process with polymeric membranes, and explain the minimum required membrane performance. In addition the latest membrane developments and characterization results under humid conditions within the MemBrain-Project at HZG will be presented.	
09.06.	Prof. Peter Horst, TU Braunschweig	Prof. Norbert Huber
	<u>Fatigue phenomena in multiaxially loaded GFR-specimens</u>	
23.06.	No seminar	
07.07.	Dr. Williams Lefebvre, Groupe de Physique des Matériaux, UMR CNRS 6634, Université de Rouen, FRANCE	Dr. Norbert Hort
	<u>Early stages of precipitation in the Mg-0.5at% Nd system studied by HAADF STEM and Atom Probe Tomography</u> Among the Mg-RE (rare earth) alloys, which are good candidates for high temperature creep resistant lightweight alloys, Nd containing systems provide an interesting combination of mechanical and corrosion properties. The high strength achievable in the binary Mg-Nd system, which is a good model of commercial alloys like WE43 and WE54 alloys, is due to age hardening. Indeed, heat treatments of a retained supersaturated solid solution in the range 150-250°C currently lead to the formation of a large number density of tiny-scale (meta-) stable precipitates which is accompanied by a significant increase in hardness and mechanical properties. Though the age hardening response in Mg-Nd is known for a long time, the supposed DO19 or c-base centred orthorhombic structures of hardening precipitates and the eventual formation of GP-zones in this system are the subject of controversy. In the present work, the characterization of Nd-rich precipitates during the very early stages of precipitation has been undertaken by means of Atom Probe Tomography and Cs-probe corrected HAADF STEM. With this later technique, supplementary information is provided to standard atomically resolved high resolution projections of the	

	crystal lattice, thanks to the so-called “Z-contrast”. By determining the respective positions of Nd-rich columns in precipitates, both the structure and the evolution of precipitates during isothermal ageing of the supersaturated solid solution have been achieved and are presented in details. The study reveals that Nd-rich precipitates consists in several kinds of Neodimyum cells. The evolution of Neodimyum cells with ageing time is found to control the nature of precipitates and their orientation with respect to the matrix.	
2. Jahreshälfte / 2. Half Year 2011		
03.11.	No seminar	
17.11.	Priv.-Doz. Dr. med. Dr. biol. hom. Volker Alt, Universitätsklinikum Giessen-Marburg	Prof. Regine Willumeit
	“Biomaterialien der Zukunft – Was benötigt der Unfallchirurg und Orthopäde in den nächsten Jahren?” Trotz vieler Fortschritte in den letzten Jahren gibt es eine Vielzahl ungelöster Probleme für Patienten mit unfallchirurgischen bzw. orthopädischen Krankheitsbilder, z.B. Osteoporose, Knocheninfektionen, Knochenbruchheilungsstörungen etc. Eine Verbesserung der Behandlung hierfür erhofft man sich durch den Einsatz neuer, innovativer Biomaterialien in diesem Zusammenhang. “Klassische” Knochenersatzmaterialien, wie Hydroxylapatit, Calcium-Phosphat-Zemente etc. haben zwar in den letzten Jahren einen kontinuierlichen Einzug in die operative Behandlung von Patienten mit Knochendefekten gehalten und werden für die Zukunft die Basis für weitere Entwichlungen in diesem Feld darstellen. Beschichtungen bzw. Zusatz von bioaktiven Substanzen, wie z.B. Wachstumsfaktoren, Antibiotika, anti-osteoporotischen Substanzen etc. für Knochenersatzmaterialien bzw. für chirurgische Implantaten bieten hohes Potential, um Behandlungsergebnisse für Patienten zu verbessern. Der Vortrag liefert Einblicke in die zellulären Prozessen der Interaktionen zwischen Biomaterialien und körpereigenem Gewebe, z.B. Blugefäß- und Knochenneubildung, sowie in die klinischen Anforderungen für zukünftige Biomaterialien.	
08.12.	Dr. Domonkos Tolnai	Prof. Kainer
	3D characterization of microstructure evolution of cast AlMgSi alloys by synchrotron tomography Cast AlMgSi alloys are well established for automotive and aerospace industry. These alloys are multiphase materials containing a rigid eutectic phase of Mg2Si embedded in the ductile -Al matrix. This system acts like a composite material where the internal architecture of the eutectic phase plays a vital role in the macroscopic behaviour. Extensive studies have been performed before to reveal the relation between the morphology of the eutectic microstructure and the mechanical properties of the material. Through the internal architecture, which can be modified by varying the casting conditions or applying heat treatments, the mechanical properties of the material can be tailored. To follow and quantify the changes in the microstructure the application of a non destructive 3D imaging technique is necessary. The aim of this work is to study the evolution of the microstructure of two	

	cast AlMgSi alloys: an AlMg7.3Si3.5 alloy, with an Mg:Si ratio above the stoichiometric Mg2Si ratio and an AlMg4.7Si8 with an Mg:Si ratio below the stoichiometric Mg2Si ratio. The development of the -Al dendrites and of the eutectic structure have been followed and quantified by synchrotron tomography during in situ solidification tests. The transformation of the eutectic Mg2Si morphology during solution heat treatment was investigated by ex situ synchrotron tomography. The quantitative results of the morphological changes are correlated with the changes in the elevated temperature strength and hardness of the investigated materials. The solidification of the alloys has been investigated by in situ synchrotron tomography during continuous cooling from liquid to solid state in order to follow the solidification sequence and thus study qualitatively and quantitatively the morphological evolution of the solidifying phases. The analysis of the tomographies shows that the dendritic growth of both alloys is characterized by a coarsening of the secondary dendritic arms ending up in a droplet-like shape at the eutectic temperature. This means that during solidification the smaller secondary dendrite arms disappear, while the larger ones continue to grow resulting in the coalescence of the secondary dendritic arms. The onset of the eutectic solidification takes place at the interface in the liquid between -Al secondary dendritic arms. The volume fraction of the eutectic Mg2Si particles increases during solidification, with a growth rate of the largest Mg2Si particle higher than the average. The level of interconnectivity of the eutectic Mg2Si phase shows a monotonic increase while the growing particles coalesce. The solidification sequences of the phases are determined based on in situ imaging and the Differential Scanning Calorimetry results and are correlated with thermodynamical simulations. The evolution of the microstructure during solution heat treatment at 540C was investigated by means of Scanning Electron Microscopy and ex situ synchrotron tomography. The eutectic Mg2Si phase, which presents a highly interconnected structure in the case of both materials in as-cast condition, undergoes significant morphological changes during solution heat treatment. This transformation is characterized by a disintegration of the interconnected seaweed-like structure followed by a spheroidisation of the disintegrated fractions of the eutectic branches. The ternary eutectic Si resulting from the Si-surplus in AlMg4.7Si8 undergoes similar changes. The morphological evolution during solution treatment is correlated with results from elevated temperature compression tests at 300C and room temperature hardness tests. The eleveated temperature strength and the hardness of the investigated alloys decrease during solution heat treatment as a consequence of the loss of interconnectivity of the eutectic Mg2Si structure.	