MM 58: Topical session: X-ray and neutron scattering in materials science III - Real-time insights into fast heat treatment processes using diffraction methods

Time: Thursday 15:45–17:15 Location: BAR 205

Topical Talk MM 58.1 Thu 15:45 BAR 205

Real-time insights into fast heat treatment processes using diffraction methods — •Jens Gibmeier[1], Vladimir Kostov[1], Fabian Wilde[2], Peter Staron[2], Arne Kromm[3], Thomas Kannengiesser[3], and Alexander Wanner[1] — [1]KIT, Inst. of Applied Materials, Karlsruhe, Germany — [2]Helmholtz-Center Geesthacht, Inst. of Mat. Res., c/o DESY, Hamburg, Germany — [3]BAM Federal Inst. for Mat. Res. and Testing, Berlin, Germany

Laser surface hardening and related processes are viable techniques for surface integrity optimization of technical components. Although, the techniques are standard processes in industrial applications, process optimization is essentially based on simulation and on characterization after material processing. Moreover, the simulations often lack in an adequate accuracy, since the models are still deficient. Knowledge about the phase transformation kinetics and about the evolution of local (residual) stress distributions is of essential importance for the optimization of the surface hardening process and hence, for the tailoring of the treated surface layers. A considerable progress can be achieved when a real-time insight into these local short-time heat treatment processes can be gained. By this means process comprehension can be achieved as well as a proper validation of the simulation models can be offered. Here, different set-ups for real-time monitoring of phase transformation as well as stress evolution during fast heat treatment processes by means of synchrotron X-ray diffraction will be presented. Successful application for laser surface hardening and arc welding will be shown.

MM 58.2 Thu 16:15 BAR 205

Texture evolution of YCu deformed by high pressure torsion — •Aurimas Pukenas[1], Andy Eschke[1], Werner Skrotzki[1], Christine Tränkner[1], Jelena Horky[2], and Michael Zehetbauer[2] — [1]Institut für Strukturphysik, TU Dresden, Dresden, Germany — [2]Fakultät für Physik, Universität Wien, Wien, Austria

YCu is an intermetallic compound with B2 type crystal structure which is ductile at ambient temperature and pressure. Polycrystalline YCu discs were subjected to high pressure torsion (HPT) at a confining pressure of 8 GPa from room temperature up to 300°C. In HPT the deformation of the sample is inhomogeneous along the radial direction. Due to this shear strain gradient, a texture gradient is observed. The texture was measured locally as a function of shear strain by X-ray microdiffraction. The intensity and deviation from the ideal positions of the typical bcc texture components will be discussed and compared to NiAl, another B2 intermetallic compound which is brittle at ambient temperature and pressure conditions.

MM 58.3 Thu 16:30 BAR 205

Application of in-situ high-energy X-ray diffraction and small-angle scattering for the understanding and development of advanced intermetallic multi-phase γ-TiAl based alloys — •Emanuel Schwaighofer[1], Andreas Stark[2], Peter Staron[2], Boriana Rashkova[1], Thomas Lippmann[2], Norbert Schell[2], Helmut Clemens[1], and Svea Mayer[1] — [1]Department of Physical Metallurgy and Materials Testing, Montanuniversität Leoben, Austria — [2]Institute of Materials Research, Helmholtz-Zentrum Geesthacht, Germany

Advanced intermetallic γ-TiAl based alloys, e.g. TNM alloys with a nominal composition of Ti-43.5Al-4Nb-1Mo-0.1B-(0-1)C,Si (in at.%), are predestined for high-temperature (HT) application as turbine blades and turbocharger wheels in modern combustion engines. To improve their HT-potential, state-of-the-art methods based on high-energy monochromatic synchrotron radiation were applied combined with an adapted quenching and deformation dilatometer in order to study equilibrium and non-equilibrium phase transformations, hot-deformation behavior, texture evolution as well as carbide precipitation kinetics. Complementary real-space imaging by means of scanning and transmission electron microscopy as well as lab-scale XRD and hardness testing were performed for verification. In this talk, selected topics of the use of in-situ synchrotron scattering techniques, i.e. diffraction and small-angle scattering, conducted at HZG-operated beamlines HARWI II and HEMS at the synchrotron facility DESY, Germany, are discussed for a deeper understanding of this class of alloys.

MM 58.4 Thu 16:45 BAR 205

In situ high energy X-ray diffraction for analyzing the local stress distribution and microstructure in the chip formation zone during orthogonal cutting of steel C45E — •Katrin Brömmelhoff[1], Steffen Henze[2], Robert Gerstenberger[2], Torben Fischer[3], Norbert Schell[3], Eckart Uhlmann[2], and Walter Reimers[1] — [1]TU Berlin, Materials Science and Technology-Metallic Materials, Ernst-Reuter-Platz 1, 10587 Berlin, Germany — [2]TU Berlin, IWF, Pascalstr. 8-9, 10587 Berlin, Germany — [3]Helmholtz-Zentrum Geesthacht, Max-Planck-Str. 1, 21502 Geesthacht, Germany

The stress distribution in the chip formation zone during cutting is an asked question in the field of manufacturing technology and is required for a fundamental understanding of the chip formation process. New synchrotron facilities with high photon flux provide the opportunity to measure the local strains with a high spatial resolution. Therefore, the steep stress gradients in the chip formation zone can be analyzed. Performing in situ high energy synchrotron X-ray diffraction during orthogonal cutting at the HEMS beamline (PETRA III/Hamburg), the beam size and therefore the measuring positions could be reduced to 0.02 mm x 0.02 mm. The stress distribution exhibits steep stress gradients and shows significant dependencies on the cutting parameters and a strong change of the microstructure was observed, namely a reduction of domain sizes and the development of a shear texture. The results of these in situ experiments serve to evaluate and extend existing chip formation models and will be used for the optimization of FEM (Finite Element Method) cutting simulations.

MM 58.5 Thu 17:00 BAR 205

Synchrotron radiation based non-destructive investigation of Neolithic and Early Bronze Age axe — •Leif Glaser[1], Mechtild Freudenberg[2], Karen Appel[1], Manuela Borchert[1], Joern Donges[1], Andrew King[3], Thomas Lippmann[4], Andre Rothkirch[1], and Norbert Schell[4] — [1]DESY, Hamburg, Germany — [2]Stiftung Schleswig-Holsteinische Landesmuseen, Schloß Gottorf, Schleswig, Germany — [3]ESRF, Grenoble, France — [4]HZG, Geesthacht, Germany

To understand the historic production methods bronze axe replicas were cast and treated using replicated stone tools for metalworking. To understand techniques for smoothing the surfaces, hardening the cutting edge, and cutting or embossing the elaborate ornaments of the surface, repeated investigations, using non-destructive SR-based techniques, as XRF and XRD in transmission and reflectance geometry were performed on the replicas and original ancient axes.

Based on our experiments the reproduction techniques for making replicas could be improved, while on the other hand some historic references could be identified as historic forgeries, but forgeries nonetheless. Further experiments concerning the actual casting process are ongoing, with emphasis on most likely casting inflicted variable stoichiometric bronze distribution within the individual object. Some replica were cast at the Howadtsche Metallgiesserei Kiel using modern casting techniques, others at the Archaeological Landesmuseum Schloß Gottorf using historic methods and tools only, while the experiments were performed in Hamburg at DESY.