MM 25.7 Wed 15:30 P4

Experimental Residual Stress Analysis of Hertzian Loaded Machine Parts — •Jürgen Gegner — SKF GmbH, Material Physics, Ernst-Sachs-Str. 5, D-97424 Schweinfurt, Germany

X-ray diffraction measurement represents an established testing tool for material response or residual life and failure analysis of machine elements that are highly loaded under Hertzian-contact fatigue conditions. The modified industrial-suited technique is described in detail and its application illustrated considering rolling bearings as example. Apart from the residual stress depth profiles, which could simpler be determined by the mechanical hole-drilling method, the martensite {211} line broadening characterizes material aging of hardened steels. Under rolling contact, the loaded volume in the edge zone sustains continuous constitutional changes, such as microstructure transformation (e.g. retained austenite decay) or carbide dissolution, caused by energy dissipation. By means of the X-ray diffraction technique, alterations of residual stresses and line broadening can be detected. For quantitative evaluation of these measured distance curves, calibration data, which permit comparison with the statistical parameters of the Weibull failure frequency distribution in the form of the L10 life equivalent, is available for ball and roller bearings.

MM 25.8 Wed 15:30 P4

Near- and Sub-Surface Fatigue of Rolling Bearings — •Jürgen Gegner — SKF GmbH, Material Physics, Ernst-Sachs-Str. 5, D-97424 Schweinfurt, Germany

Material response of hardened steel to rolling contact starts with strain strengthening in the plastically deformed edge zone and the build-up of compressive residual stresses in the short shakedown period. The following steady-state stage controls a certain part of bearing lifetime, the duration of which depends on the loading conditions. The depth profiles of the equivalent stresses that are defined by the applied Hertzian pressure determine the positions of maximum residual stress (v. Mises) and material aging (orthogonal shear stress). In the final instability stage, steel softening occurs and is accompanied by decreasing XRD half width: in the classical Voskamp sub-surface rolling contact fatigue mode, high residual stresses can be built up, the magnitude of which correlates to the external load. On the other hand, for instance in case of boundary lubrication with metal-metal contact, the Nierlich (near-) surface failure mechanism is characterized by diminishing stress levels. In order to investigate this practically most important damage mode in more detail, X-ray diffraction based material response analysis of gear roller bearings stemming from rig tests is performed.

MM 25.9 Wed 15:30 P4

Investigation of micro-cracks and micro-cavities in rocks by means of tomography — •S. Zabler[1], K. Thermann[2], B. Kremmin[2], A. Rack[3], I. Manke[1], N. Kardjilov[1], and A. Haibel[1] — [1]Hahn-Meitner-Institut Berlin, Abteilung Strukturforschung — [2]TU Berlin — [3]Forschungszentrum Karlsruhe - ANKA

The investigation of the microstructure of hard rock as greywacke, limestone or basalt is of special interest for basic research in applied geosciences. Hard rocks are composed of minerals, pores and micro-cracks containing gas or fluids. Technical parameters as permeability, uniaxial compressive strength and deformability (Young modulus) depend on the particular combination of the three phases. First of all, the influence exerted by the cavities as well as the closed and opened micro-cracks on the technical relevant parameters is a subject of research. It is known that compressive deformation is accompanied by nucleation, growth and coalescence of many small fractures. To obtain quantitative information of the pattern of micro-cracks in the past many research projects were performed using geophysical as well as microscopic techniques. In this work high resolution synchrotron tomography and neutron tomography are used for analysis of micro-cracks, micro cavities and the chemical composition of limestone and greywacke and basalt. The rocks were measured before and after uniaxial compression. It was possible to determine where and how micro cracks are initiated.

MM 25.10 Wed 15:30 P4

Physical aspects complete butt runout measuring — •Maryna Aliakseyeva — Minsk

In the given work the improved instrument for measuring complete butt runout is offered. The main features of the offered construction are parts broad range measuring possibility, small overall dimensions, simplicity in operation and high received end measures accuracy. This work concerns the physical aspects of measuring process. The offered construction can find broad applying in the field of metrology and quality control.

MM 25.11 Wed 15:30 P4

Advanced high strength and ductile Fe-based materials — •Katarzyna Werniewicz[1], Uta Kühn[1], Norbert Mattern[1], Birgit Bartusch[1], Ludwig Schultz[1], and Tadeusz Kulik[2] — [1]IFW Dresden, P.O. Box 270016, D-01171 Dresden, Germany — [2]Faculty of Materials Science and Engineering, Warsaw University of Technology, Wołoska 141, 02-507 Warsaw, Poland

We report about phase formation and mechanical behavior of copper mold cast Fe-Cr-Mo-Ga alloys. The rod-shaped samples with a diameter of 3 mm were prepared by centrifugal casting technique using different crucible materials. Interestingly, the samples prepared under different conditions show significant different microstructures and mechanical properties. It was found that one of the samples consists of a ductile bcc α-Fe phase embedded in a fcc Fe_3Ga. In order to characterize the mechanical properties of our alloy, Vickers hardness and room temperature compression tests were performed. The measured hardness of the α-Fe phase is about two times smaller (4.48 GPa) than the hardness of Fe_3Ga (8.08 GPa). The combination of the ductile and high strength phase leads to a material with high fracture strength (3 GPa) connected with excellent ductility (15%). This mechanical behavior has never been observed before for any Fe-based crystalline as well as bulk glassy alloys. We assume that these unique mechanical characteristics result from the formation of the specific two-phase structure, which occurs during the casting considering certain parameters.

MM 25.12 Wed 15:30 P4

The influence of doping with Ni on viscosity of liquid Al — •Andriy Yakymovych, Stepan Mudry, Vasyl Sklyarchuk, and Volodymyr Halchak — Physics of Metals Department, Ivan Franko Lviv National University,Kyrylo I Mephodiy Str. 8, 79005, Lviv, Ukraine

The addition of Ni to aluminium allows to improve its physical-chemical properties, which are important for practical use. It is interesting to clarify how change the main properties of Al in liquid state upon doping. On that, reason the viscosity of Al-Ni molten alloys with 2.5, 5, 7.5 at.% of Ni has been studied in this work by means of oscillating crucible method. Analyzing the available data on viscosity of Al and Al-based alloys one can conclude that there is a discrepancy between them.

Temperature dependence of viscosity coefficient for melts of various Al content shows Arrhenius like shape. With addition of Ni-atoms to aluminium the viscosity coefficient increases. The experimental data were compared with ones calculated for hard sphere model.

It is shown that chemical atomic ordering which is more pronounced for higher content of Ni may be the main reason of observed viscosity and activation energy change. We suggest that due to preferred interaction of Al and Ni atoms associates are responsible for the viscosity changes of neareutectic molten alloys. The content of Al and Ni in such chemically ordered structural units can vary in some wide range. This range is supposed to be significantly wider than homogeneity range for solid AlNi compound.

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Tomographic atom probe (TAP) study of the chemical ordering in bulk amorphous alloys — •A. Shariq[1], T. Al-Kassab[1], R. Kirchheim[1], D.J. Safarik[2], and R.B. Schwarz[2] — [1]Institut für Materialphysik, Friedrich Hund Platz 1, D-37077, Göttingen, Germany — [2]Los Alamos National Laboratory, MST Division, Structural Property relation group, Los Alamos, NM 87545, USA

Amorphous alloys are characterized by the absence of atomic long range order and reveal only topological and sometimes chemical short range order. The wider supercooled liquid region in new amorphous alloys allows to explore the kinetics and thermodynamics in this region. In this study Pd based amorphous alloys are investigated using the TAP. Atomic scale chemical ordering in such alloys put great demands on the characterizing techniques. The 3D-tomographic atom probe (TAP) is proved to be currently the best experimental tool to gain information on chemical heterogeneities at the atomic scale. A new algorithm has been developed, which enables to extract information from the TAP data. The reconstructed volume has been used to elucidate the atomic distance between neighbouring atoms. Pd40,5Cu40,5P19 bulk amorphous alloy are produced as 2 mm diameter rod with the length of almost 46mm. The chemical ordering parameters elucidated by this algorithm for this Pd based amorphous alloys are discussed in this contribution.