ICOTOM 18

18th International Conference on Textures of Materials

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Symposium C: Texture and Microstructure Characterization

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C-1 Texture Analysis using High Energy Material Science Beam Line (HEMS)@Petra III/Hasylab-Hamburg

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The high-energy materials science (HEMS) beamline of the Helmholtz-Zentrum Geesthacht (HZG) is part of the Max von Laue Hall at Petra III storage ring. An energy range between 30 to 200 keV is available for diffraction and imaging. While DESY runs one hutch for hard X-ray experiments, two hutches and the side station were operated by HZG mainly **for** engineering materials science applications. Orientation analysis can be done with a conventional set up for pole figure measurement including test rig and furnace as well as with grain mapping obtaining 3DXRD information. The present contribution deals with conventional pole figure measurement.

Due to the great advantages of high energy synchrotron radiation with excellent brilliance and high penetration power pole figure measurements were carried out measuring texture gradients with a typical beam size of 100µm x 100µm. Examples of texture gradients in tubes, severe plastic deformed material, welds and finished products will be presented. Compared to other methods, pole figure measurement by synchrotron radiation is fast with excellent counting statistics, so that ideal conditions for in situ studies exist. Texture evolution under applied load, compression as well as tension, or under annealing gives perfect results. Experiments at different Mg-alloys, shape memory alloys, Al-alloys and Ti-alloys have been carried out.

Disadvantages of synchrotron radiation are the long elliptical shape of the pole figure window, the small gauge volume and the extreme parallel beam. Problems can arise in case of un-sufficient grain statistics and in some case of inhomogeneous textures distributions. Means in all cases in which the texture changes during pole figure measurement.

[1] H.-G. Brokmeier and Sang Bong Yi: Texture and Texture Analysis in Engineering Materials, In: Neutrons and Synchrotron Radiation in Engineering Materials Science, W. Reimers, A. Pyzalla, A. Schreyer, H. Clemens (eds.), Wiley VCH Verlag, Weinheim, 2008, pp.57-77.

C-2 Comparison of preferred orientation of austenite and ferrite phases of duplex steel with rolled single phase austenitic and ferritic steel

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The preferred orientation plays an important role in the various branches of industry. Preferred orientation result in changing of material properties depending on the significant direction [1].

In this contribution, the behavior of three type of steel after rolling were investigated. Particular phases of duplex steel have different mechanical and thermal properties [2]. Due to their mutual influence during plastic deformation, it is possible to suppose the differences between preferred orientations of austenite and ferrite phases of duplex steel with single-phase austenitic and ferritic steel. For this reason, the preferred orientation of austenite and ferrite phases of rolled 1.4470 duplex steel with rolled single phase 1.4301 austenitic and 1.4021 ferritic steel were compared. The 0–50% reductions of rolled steel plates were selected. Mainly, the strength and type of preferred orientation in relation to reduction and material were compared. Moreover, preferred orientation was investigated by X-ray diffraction and electron back-scattered diffraction (EBSD).

[1] H. Hu (1974) *Texture*. **1**, 233–258.

[2] R. Dakhlaoui, Ch. Braham & A. Baczmański (2007) *Mater. Sci. Eng.: A.* **444**, 6–17.

C-3 Quantitative Fiber Diffraction: from polymers to composites

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Fiber diffraction is a specific technique aimed at measuring the strong texture of polymers or inorganic fibers using an X-ray transmission setup and a 2D detector. The obtained single shot image is then analyzed qualitatively to identify the main texture components from the strong diffraction spots. In this work we aim to show how the combination of this experimental technique with the adoption of the standard components inside the Rietveld Texture Analysis (RTA) [1] can provide a quantification of the sharp orientation distribution function. With this method, we can follow the texture evolution of polypropylene or nylon fibers, before and after thermal and mechanical treatment, quantifying the polymeric chains dispersion with high accuracy. A more complex case is represented by the addition of a stiffener like a Smectite or a Kaolinite to a polymer fiber. In the case of Kaolinite, the modeling inside the Rietveld is further complicated by the modulated planar disorder typical of this clay mineral. We will show how the adoption of a modified single layer approach [2], to account for the modulated disorder, will help obtaining at once, the full texture of both phases as well as the strained and highly defective structure of the Kaolinite. This helps understanding the actual degree of intercalation inside the fiber to further optimize the composite.

The only filtered radiation, used in this experimental setup, represented an additional problem as relatively strong spots are visible in the diffraction images due to the sharp texture and residual Bremsstrahlung. The adoption of the Ebel tube description [3] is sufficient for the modeling of these extra spots and to solve elegantly the problem. This opens the question if it would be more efficient to use non monochromatic radiation, as in a true Laue camera, to analyze this kind of sharp textures, that make fibers closer to single crystals than to polycrystalline materials.

[1] L. Lutterotti, M. Bortolotti, G. Ischia, I. Lonardelli and H. -R. Wenk (1997) *Z. Kristallogr.* Suppl. **26**, 125.

[2] L. Lutterotti, M. Voltolini, H. -R. Wenk, K. Bandyopadhyay and T. Vanorio (2010) *Am. Mineralogist* **95**, 98.

[3] H. Ebel (1999) *X-ray Spectrometry* **28**, 255.

C-4 Practical applications of nondestructive texture measurement methods

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The present poster introduces practical applications of new, sample cutting-free texture measurement methods developed for centerless X-ray diffractometers. The possibilities offered by the techniques are shown through practical implementations of the methods from the field of metal forming, mineralogy and archaeometry using a certain type of centerless X-ray diffractometer. The execution of the measurements and the required minor hardware modifications are also presented.

C-5 Rotation angle optimization for texture measurement using TOF neutron diffraction

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Bulk texture measurements using pulsed neutron diffraction is a routine application of the HIPPO (High-Pressure-Preferred Orientation) instrument at LANSCE (Los Alamos Neutron Science Center), but is also available at GEM/ISIS, iMATERIA/J-PARG or NOMAD/SNS. Each of these instruments makes use of a vast detector coverage and typically several rotations are employed to maximize this coverage. However, to the best of our knowledge, a tool to optimize the measurement angles to maximize the pole figure coverage is not available. Here, we describe an approach employing the *General Mapping Tool (GMT)* and *ImageJ* to quantify the coverage achieved by a given combination of measurements and rotation angles. Our approach consists of the following steps:

- Measure the detector panels' positions in the real space and project them on a two-dimensional plane in an equal area projection.
- Rotate the projected image by given rotation angles.
- Superimpose all of the rotated images on the initial one and calculate the area fraction of detector panels.

With this approach, we find that for HIPPO with 45 detector panels around the diffraction center, covering 40°, 60°, 90°, 120° and 144° nominal diffraction angles, the pole figure coverage is about 35%. Through the aforementioned procedure it was clarified that the coverage for the current standard angle set (0°, 67.5°, 90°) is 67.8%. The coverage could be increased to 71.5% by adopting the optimized angle set (0°, 55°, 215°). The method is applicable to any instrument for which detector coordinates are available.

C-6 ANDES: a multi-purpose neutron diffractometer for the RA10

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The Argentinean Atomic Energy Commission (CNEA) is building a multi-purpose research reactor in Centro Atómico Ezeiza, 30 km from Buenos Aires Argentina, with commissioning planned for mid 2020. The RA-10 will be an open-pool facility for radioisotope production, materials and fuel irradiation, silicon doping and neutron techniques applications. Associated to this last goal there is a separate project to build the Argentinean Neutron Beams Laboratory (LAHN), also executed by CNEA and funded by the National Government. The first stage of LAHN project includes two instruments of particular application in (nuclear) materials research and development. One of them is ANDES (Advanced Neutron Diffractometer for Engineering and Science), a multi-purpose neutron diffractometer for materials science and engineering applications, able to perform a variety of analysis, both on intact objects and on small samples. The techniques available include strain scanning, texture measurement, and high intensity powder diffraction on a variety of environments. The development of this instrument is supported in 4 main areas: shielding design, mechanical engineering design, neutron optics and automation and control. In this work we present the advances in the conceptual design of the instrument.

C-7 Progress on the Development of Texture Analysis Capabilities at the HFIR and SNS at ORNL

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Knowledge of the crystallographic preferred orientation of a polycrystalline material provides critical information needed to both predict how the material will behave in service, and understand how and why the material failed in operation. While EBSD and X-ray techniques are routinely used to quantify texture, these approaches are surface sensitive. The obtained surface information is not always representative of the bulk. In contrast, the high penetration nature of neutrons make them ideal for investigating bulk textures. HIPPO had served the scientific community since the early 2000s. However, the loss of the user program at the Lujan center has severely constrained access to HIPPO. While not specifically designed for texture analysis, instruments at the HFIR and SNS at ORNL are well suited to address the needs of the scientific community. This poster will present recent work on quantifying crystallographic textures in materials using various instruments at the HFIR and SNS at ORNL. For example, work at HB2B at the HFIR on additively manufactured 718 Inconel has demonstrated that the processing parameters can