All of the well-loved program systems have their roots in ideas formed about 30 years ago, and have evolved slowly under the care and attention of individuals or small groups. These programs ***express*** the knowledge held by these people, but they do not document it.

The equation $A^T.A.\delta x = A^T.\Delta F$ sums up what happens in least-squares, but it requires a lot of code to convert this into even a simple useable program, and a massive amount of understanding of the problem and environment to turn it into a user-friendly program.

The principal writers and care-takers of the most popular programs are now in the final phases of their careers. When they shuffle off their mortal coils, devotees may be able to keep some of the programs running for a short while, as a kind of working museum. Every thing in not broken yet, so there is nothing to fix. However, if the community is to avoid re-inventing very may wheels in the future, there is urgent need to properly document current knowledge, and use it to create better wheels.

Keywords: computing, least-squares, mortal coils

MS21 Basic to Industrial Applications of Stress and Strain Analyses with Synchrotron and Neutron Radiations

Chairpersons: Alain Lodini, Lyndon Edwards

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Insights into Deformation Mechanisms from *in-situ* Diffraction Experiments

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The usage of neutron and synchrotron x-ray diffraction as a tool to measure internal stresses has increased significantly in recent years. While a great deal can be learnt about the influence of processing and fabrication routes on materials by studying samples after processing, it is often beneficial to carry out controlled loading experiments. Loading samples *in situ* in the diffracting beam provides a direct insight into the micromechanical deformation mechanisms contributing to the macroscopic response of the sample as a whole, under user imposed environmental conditions. Combined with micromechanical modelling a great deal can be learnt regarding the way that the various mechanisms operate and interact, for example different slip modes and/or phase transformations. While both neutrons and synchrotron x-rays probe bulk rather than surface properties, the two techniques provide different opportunities and different challenges for such experiments. The techniques and capabilities will be explored via examples of studies of the deformation of metal and ceramic polycrystals.

Keywords: deformation, internal stress, plasticity

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Strain Mapping Methods and Instruments: Recent Advances and Future Implications

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Neutron diffraction is now a relatively mature technique for strain mapping in engineering materials and components. Synchrotron X-ray diffraction methods are developing rapidly, and for some applications offer more efficient data collection. The fundamental principles of diffraction methods for strain determination, and subsequent calculation of stress, are well-understood. Much of the improvement in the applicability of neutron and synchrotron X-ray methods in the last 10 years has been achieved by improvements in instrumentation and the development of dedicated diffractometers for strain measurement and mapping. This has allowed for better sample positioning and accommodation of bulkier and weightier samples. At the same time, there have been improvements in neutron optics and our understanding of beam attenuation effects.

This talk will review some of these developments, in the context of the new engineering-oriented diffractometers that have been developed in the last five years. Results will be presented from applications that could not have been achieved ten years ago. It will also look forward to the possibilities of future developments which will further expand the scope and applicability of engineering diffraction measurements of strain.

Keywords: residual stress analysis, strain mapping, engineering materials

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Contribution of Numerical Simulation to Stress Evaluation by Neutron or Synchrotron Diffraction

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As demonstrated by various round robin tests, stress evaluation by neutron diffraction or synchrotron radiation is reliable when the probe volume is completely immersed in the studied material. However, near surface measurements or acquisitions carried out close to interfaces are much more difficult to analyze, due to parasitic shifts of the diffraction peaks which are obtained in such condition.

This study shows the contribution of numerical simulations to solve this problem. It demonstrates that a complete modeling of diffractometers by a Monte Carlo method allows defining precisely the size and shape of the probe used. It permits then predicting the evolution of the diffracted intensity versus the position of this volume in the matter. This approach allows also determining and correcting all systematic shifts of the diffraction peaks which appear when measurements are carried out near the surface or close to an interface. The calculations finally let to define the real analyzed depth, accounting for the local conditions of diffraction and absorption in the material. The experimental procedures implemented thanks to the numerical simulations strongly improve the space resolution of the neutron and synchrotron stress evaluation methods and reduce the uncertainties of the results. To this last end a new method for a global analysis of stress fields was developed which greatly improves the precision of measurements.

Keywords: stress, synchrotron radiation neutron, simulation

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Study of Elasto-plastic Deformation in Mg Alloy Using Synchrotron Radiation

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Strain scanning using monochromatic and white beam X-rays is becoming increasingly popular for measuring the residual and live stresses within engineering samples and test pieces.

This work presents the results of a study of elasto-plastic deformation in bent bars of magnesium alloy using 68.5 keV monochromatic synchrotron X-rays and white radiation. We have developed a fast monochromatic method where an aperture is scanned across an image plate exposing a fresh part of the plate at each step, and the sample is simultaneously scanned through the X-ray beam. A complete set of 'diffraction segments' are recorded on the image plate showing peak positions, texture and peak broadenings as a function of position in the sample. The measurements made with the energy dispersive, white beam technique are consistent with the new monochromatic method. We demonstrate that information about plastic deformation can be successfully extracted not only from peak shape variation, but also from the relative peak positions (difference strains) between different reflections. The difference arises as a consequence of elastic and plastic anisotropy of grains in response to loading, and sheds light on the micromechanics of polycrystalline