STRAIN AND TEXTURE MEASUREMENTS USING HIGH-ENERGY X-RAYS*

J. Almer[1], U. Lienert[1], M. Odèn[2] and D. Haeffner[1]

In an important class of materials, the strain state and crystallographic texture vary significantly with depth. Examples include mechanically treated surfaces, functionally graded materials and buried interfaces. The unique characteristics of third-generation synchrotron sources, including high brilliance and high flux at high photon energies (E > 40 keV), can be exploited to examine these crystallographic properties over a wide range of penetration depths, non-destructively and with good spatial and momentum resolution. An experimental effort to use these capabilities at sector 1 of the Advanced Photon Source is presented. The approach is based on use of monochromatic high-energy x-rays, a Laue scattering geometry and a large two-dimensional area detector. Specific benefits with regards to strain information include (i) measurement of the scattering vector **q** about 360º of a given axis, (ii) measurement to high **q** values (e.g. ~1Å^{-1} without detector motion), (iii) ability to measure small crystalline volumes and thus strain gradients, and (iv) simultaneous collection of texture information.

Equations governing strain resolution and potential errors under this configuration are presented, and we will show that absolute strain values can be determined to ~1x10^{-4} accuracy through the use of calibrated standards. In addition, strain analysis of 2-D data is presented for weakly and strongly textured systems. In the former case, phase strains are monitored during *in situ* tensile loading of a duplex stainless steel and are found to be well represented by standard strain analysis. In the second case, the strain in highly textured CrCN coatings is measured in cross-section with a rectangular beam (~10mm along the 70mm coating thickness x 300mm wide), and found to vary non-linearly as a function of $\mathbf{q}_{hkl}$. These results are treated by inclusion of elastic anisotropy and texture information in the analysis.

* Work supported by the U.S. Department of Energy, BES, under contract no. W-31-109-Eng-38.

[1] Argonne National Laboratory, Advanced Photon Source, Argonne, IL, USA

[2] Linköping University, Department of Mechanical Engineering, Linköping, Sweden