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Bragg-Edge Neutron Strain Imaging and Tomography

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For more than 10 years, time-of-flight detectors at pulsed neutron sources have been capable of providing high-resolution images of strain fields through Bragg-edge analysis [1]. With a geometry akin to a traditional radiograph, these images represent a projection of the full 3D tensor strain distribution to a scalar field. This poses a rich tomography problem based on a generalised version of the Radon transform known as the Longitudinal Ray Transform (LRT). The solution to this Bragg-edge strain tomography problem promises a new approach by which the full triaxial elastic strain (and hence stress) distribution could be observed within crystalline solids over the scale of centimetres.

This presentation will provide an overview of Bragg-edge imaging and strain measurement before outlining recent work by the Authors focused on solving the associated tomography problem. The central issue that rendered the problem ill-posed will be discussed before introducing a range of approaches based on equilibrium constraints.

A two dimensional experimental demonstration based on data from the RADEN energy-resolved imaging instrument (at J-PARC in Japan) will be presented with comparisons to detailed constant-wavelength strain scans from the KOWARI diffractometer (ANSTO). The generalisation of this approach to three-dimensions will also be discussed.

[1] Tremsin et al. “High-resolution strain mapping through time-of-flight neutron transmission diffraction with a microchannel plate neutron counting detector”, Strain, v48 pp296-305, 2012.

Topic

Engineering & Industry

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