SRI2024

Contribution ID: **1052** Type: **Invited talk**

The Structural Materials Beamline at CHESS: An emerging facility for High Energy Monochromatic and White-beam Diffraction

Tuesday 27 August 2024 16:30 (20 minutes)

In 2019, the Air Force Research Laboratory established the Materials Solutions Network at CHESS (MSN-C): a sub-facility of the Cornell High Energy Synchrotron Source (CHESS) created to provide critical measurements and research products to U.S. Department of Defense (DoD) researchers and defense Original Equipment Manufacturers (OEMs). The Structural Materials Beamline (SMB) is one of two beamlines comprising MSN-C. It is optimized to characterize structural (primarily metallic) materials across a broad range of length- and time- scales for the purpose of investigating the impact of conventional and emerging alloy/material design and manufacturing/processing pathways through both in situ and ex situ experimental campaigns. Specialized instrumentation and methods have been developed to characterize the real-time thermal-mechanical response of alloys and to map residual stress fields in metallic components (e.g. titanium fan blades from jet engines) through diffraction-based techniques.

SMB operates in two modalities: white beam (50-200keV) for energy dispersive diffraction, and a high-energy monochromatic beam (40-90keV) for transmission powder diffraction and high energy diffraction microscopy. Over the past 5 years, SMB has focused on the development of standards, automation, hardware developments, and maturing workflows to transform X-ray techniques from specialized capabilities requiring a high level of user training into engineering tools accessible to non-academic groups. This talk will describe some of the milestones and capabilities (i.e. hardware, controls, and analysis) that have been developed over this period, including a 23-element energy dispersive detector, an industrial robot (50 kg payload) for sample manipulation, laser feedback positioning strategies, and integration of a highly specialized mechanical load frame (RAMSIV) with an Eiger2 X CdTe (Dectris) detector. In addition to hardware integration, SMB has been developing data and analysis-informed data-collection workflows. These workflows are critical to the MSN-C mission of delivering rigorously validated reduced data sets to users, rather than raw X-ray data. The team has a diverse background of skills (materials, engineering, diffraction, software, and more) to work with defense and industry specialists without the expectation that users become experts in X-ray diffraction.

I plan to submit also conference proceedings

No

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Session Classification: Mikrosymposium 2/2: Beamline Innovations

Track Classification: 2. Beamline Innovations