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Laue and time-of-flight neutron diffractive imaging methods for 3D grain mapping of polycrystalline materials

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For polycrystalline materials, key material properties including strength, deformation behavior, magnetic susceptibility, weldability and stress corrosion cracking resistance depend significantly on the texture of the crystalline microstructure. Conventional assessment of texture is either limited to thin surface regions or it is destructive while only probing small fractions of a bulk specimen. Only high energy X-ray diffraction at synchrotron sources and neutrons enable quantitative studies of bulk texture. Here, we report how transformative progress in advanced Laue three-dimensional neutron diffraction tomography and six-dimensional X-ray and neutron diffraction enable to map several hundred grains and, thus, allows grain orientation assessment in the volume of centimeter-sized samples with statistical significance. Laue 3DNDT is performed with short exposure times and efficient experimental processes, utilizing a white thermal neutron beam, while the 6DXND method makes use of a wavelength-resolved beam, in a time-of-flight mode, to provide sub-grain levels of information. The non-destructive nature of both methods will support in-situ studies, while future improvements in spatial resolution shall provide with more accurate grain morphology in corresponding microstructure studies.

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