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Investigation of material deformation mechanisms during high-rate loading via simultaneous X-ray diffraction and phase contrast imaging

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ABSTRACT

Using polychromatic synchrotron radiation, high-rate X-ray diffraction has been performed in-situ during dynamic tensile loading. Strain rates of 1000/s and 5000/s have been achieved with a miniature tension Kolsky bar for superelastic NiTi and 1100-O series aluminum, respectively. Via altering the ICCD exposure time, single pulse and 22-pulse diffraction has been performed thus resulting in temporal resolutions of 153 ns and 3.37 μs, respectively. Furthermore, simultaneous Phase Contrast Imaging has been used to track the sample through-thickness deformation process. Thus, it has been demonstrated that high-speed imaging and X-ray diffraction can be concurrently performed during the dynamic Kolsky bar loading process. It is also shown that adequate signal-to-noise ratios have been achieved, thereby providing adequate information for valid XRD analysis via in-house software (WBXRD). The capability of the system will be presented via crystal *d*-spacing analysis, texture evolution, and material phase transitions. Furthermore, it is important to note that this analysis is being performed on diffraction patterns gathered at very low exposure times from samples undergoing dynamic loading, in-situ.