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Observations of Shocked Metallic Surfaces with Single-pulse X-ray Diffraction

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A single-pulse x-ray diffraction (XRD) diagnostic has been developed for the investigation of shocked material properties on a very short time scale. The diagnostic, which consists of a 37-stage Marx bank high-voltage pulse generator coupled to a needle-and-washer electron beam diode via coaxial cable, produces line and bremsstrahlung x-ray emission in a 40-ns pulse. A selected anode of either silver or molybdenum is used to produce characteristic K_α lines used for diffraction. The x-ray beam passes through a pinhole collimator and is incident on the sample with an approximately 2-mm by 5-mm spot and 1° full-width-half-maximum angular divergence. Coherent scattering from the sample produces a Debye-Scherrer diffraction pattern on an image plate 75 mm from the polycrystalline sample surface. Layered polyethylene protects the image plate from debris created during the high-explosives-driven experiment.

An experimental study of the polycrystalline structures of zirconium, tin, and aluminum under high-pressure shock-loading has been conducted with single-pulse XRD. The experimental targets were 0.1-mm-thick foils of zirconium and tin using 0.4-mm-thick vitreous carbon back windows for shock-loading. The shocks were produced by either Detasheet or PBX-9501 high explosives buffered by 1-mm-thick 6061-T6 aluminum. The diffraction patterns from both shocked zirconium and tin indicated a phase transition into a polymorphic combination of amorphous and new solid phases. Similar experiments were conducted with shock-loaded 6061-T6 aluminum to measure the shocked compression of the face-centered-cubic lattice.

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