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Time-resolved Sensing of Meso-scale Shock Compression with Multilayer Photonic Crystal Structures[1] DAVID SCRIPKA, GYUHYON LEE, CHRISTOPHER J. SUMMERS, NARESH THADHANI, Georgia Inst of Tech — Multilayer Photonic Crystal structures can provide spatially and temporally resolved data needed to validate theoretical and computational models relevant for understanding shock compression in heterogeneous materials. Two classes of 1-D photonic crystal multilayer structures were studied: optical microcavities (OMC) and distributed Bragg reflectors (DBR). These 0.5 to ˜5 micron thick structures were composed of SiO_2, Al_2O_3, Ag, and PMMA layers fabricated primarily via e-beam evaporation. The multilayers have unique spectral signatures inherently linked to their time-resolved physical states. By observing shock-induced changes in these signatures, an optically-based pressure sensor was developed. Results to date indicate that both OMCs and DBRs exhibit nanosecond-resolved spectral shifts of several to 10s of nanometers under laser-driven shock compression loads of 0-10 GPa, with the magnitude of the shift strongly correlating to the shock load magnitude. Additionally, spatially and temporally resolved spectral shifts under heterogeneous laser-driven shock compression created by partial beam blocking have been successfully demonstrated. These results illustrate the potential for multilayer structures to serve as meso-scale sensors, capturing temporal and spatial pressure profile evolutions in shock-compressed heterogeneous materials, and revealing meso-scale pressure distributions across a shocked surface.

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