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Embedded optical probes for simultaneous pressure and temperature measurement of materials in extreme conditions RICHARD L. SANDBERG, GEORGE RODRIGUEZ, LEE GIBSON, DANA M. DATTELBAUM, Los Alamos National Laboratory, ERIC UDD, Columbia Gorge Research — We present a new technique for simultaneous, in situ pressure and temperature measurements under dynamic conditions by using an all-optical fiber-based approach. While similar tests have been done previously in deflagration-to-detonation tests (DDT), where pressure and temperature were measured to 82 kbar and 400°C simultaneously, here we demonstrate the use of embedded fiber grating sensors to obtain high temporal resolution in situ pressure measurements in inert materials under precise shock loading from a gas-gun driven plate impact. The system capitalizes on existing telecom components and fast transient digitizing recording technology. It operates as a relatively inexpensive embedded probe (single-mode 1550 nm fiber-based Bragg grating - FBG) that provides a continuous fast pressure record during shock and/or detonation. Fiber Bragg grating sensors have predictable thermal and mechanical response properties with pressure spectrally shifting the reflectance peak at λ =1550 nm to the blue and temperature shifting the peak to the red. By applying well-controlled steady shock wave pressure profiles to soft materials such as PMMA, we study the dynamic pressure response of embedded fiber Bragg gratings to extract pressure amplitude of the shock wave and compare our results with in situ particle velocity wave profiles measured simultaneously.

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