

Abstract Submitted
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In-situ polymer strain diagnostics using mechanochemical sensor molecules¹ JOSEPH HOOPER, PATRICK SMITH, Naval Postgraduate School, JAMES HEMMER, JAVIER READ DE ALANIZ, University of California, Santa Barbara, BRIAN MASON, JOEL CARNEY, Naval Surface Warfare Center, Indian Head Division — We report the synthesis and initial high-strain rate response of polymer materials with embedded force-sensitive molecules. PMA, PMMA, and HTPB were polymerized directly off a spiropyran molecule which undergoes a reversible ring-opening transition upon the application of local stress from the polymer chains. Following the transition there is a distinct change in color, UV response, and vibrational spectra as the spiropyran opens into a merocyanine form similar to many fluorescent dyes. In principle, these sensor molecules allow mapping of local strains with extremely high resolution and no perturbation of overall mechanical properties. However, this transition process has previously only been studied at very low quasistatic strain-rates, and was shown to be strongly affected by the nature of the polymer matrix, proximity to the glass transition, and other factors. We present the first dynamic loading experiments on these mechanochromic polymers using gas-gun and Hopkinson bar compression. Initial results on soft, elastomeric polymer matrices suggest widespread activation of the sensor molecule at high strain-rates, but that alternate synthesis and materials preparation strategies may be required to decouple the strain activation from straight thermal activation.

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