UC RIVERSIDE UNIVERSITY OF CALIFORNIA | Materials Science and Engineering

FALL 2020 COLLOQUIUM SPEAKER

DECEMBER 2, 2020

Wednesday's 1-1:50pm ZOOM

X-Ray Phase Contrast Imaging of “in-Material” Shock-Compression Response of an Additively Manufactured High-Solids-Loaded Polymer Composite*

X-ray phase contrast imaging (X-PCI) coupled with the dynamic loading platform at the Advanced Photon Source (APS) is used to provide time- and spatially-resolved shock compression response of a high-solids-loaded polymer composite fabricated by additive manufacturing (AM). The geometric flexibility and versatility offered by additive manufacturing (3D printing) opens new pathways to control the performance of materials and functionally tailor them for given applications via structural design. Additively manufactured materials can have a wide range of structural characteristics with a hierarchy of length scales and process-inherent heterogeneities such as non-uniform constituent distribution, interfaces, pores, and cracks. Many of these features are difficult to precisely control or avoid. It is therefore, important to understand how the performance of polymer composites subjected to shock compression loading is influenced by the micro- and meso-scale structural attributes and heterogeneities. We have analyzed the shock compression response of an additively manufactured polymer composite (74 vol% particulate in UV-initiated methacrylate binder) fabricated at AFRL-Eglin. Uniaxial-strain plate-impact experiments are performed at different velocities, with impact along different directions relative to the print pattern. Time-resolved X-ray phase contrast imaging (X-PCI) is used as an interior in material diagnostic. By tracking features across the observed shock front with ~154 ns time resolution and 2.45-micron spatial resolution of the X-PCI, we are able to determine the shock velocity versus particle velocity equation of state (EOS). The volume averaged particle velocity was also obtained from surface motion captured by Photo-Doppler-Velocity (PDV) interferometry measurements, which reveals almost one-to-one correlation with the particle velocities obtained from X-PCI images. The shock-compression response along the different impact directions illustrates a linear shock and particle velocity relation with no obvious orientation dependence, likely due to the negligible amount of directional porosity on the overall scale of the 2 x 3 x 6 mm samples used in the experiments. The interior deformation fields in the samples are also quantified using digital image correlation (DIC) analyses performed on the X-PCI images providing a first-ever assessment of the average strain fields inside the polymer composite under shock-compression loading. The overall results demonstrate the utility and effectiveness of X-ray PCI for probing “in-material” equation of state and interior strains associated with shock compression of heterogeneous materials.

ZOOM MEETING ID 967 5468 5049 | PASSWORD: 495951

Dr. Naresh Thadhani
Professor & Chair
Materials Science & Engineering
Georgia Tech

Naresh Thadhani is Professor and Chair of the School of Materials Science and Engineering (MSE) at Georgia Tech (GT). He joined the GT faculty in 1992, after six-years in the Center for Explosives Technology Research at New Mexico Tech, and two years as a post-doc at CalTech. He received his B.E. (1980) from Malaviya National Institute of Technology in Jaipur, India, M.S. (1981) from South Dakota School of Mines, and Ph.D. (1984) from New Mexico Tech, all in Metallurgical Engineering. Professor Thadhani’s research is focused on the fundamental mechanisms of shock-induced physical, chemical, and mechanical changes under high-pressure shock-compression, and the deformation and fracture response of metals, ceramics, polymers, and composites, subjected to ballistic impact and high-strain-rate loading. He has led advancements in the understanding of shock-induced phase transformations and mechanical properties of bulk metallic glasses; design, development, and characterization of structural energetic materials, and the shock-compression response of highly heterogeneous (granular) materials through meso-scale computational simulations experiments with spatial- and temporally-resolved diagnostics. Professor Thadhani is recipient of the 2018 TMS Leadership award, and is the Fellow of ASM International and the American Physical Society. He is an elected Academician of the EuroMediterranean Academy of Arts and Sciences.

Please visit the MSE website for the 2020/21 Speaker Lineup