

## INVESTIGATION OF MICROSTRUCTURAL CHANGES IN IMPACTED POLYUREA COATINGS USING SMALL ANGLE X-RAY SCATTERING (SAXS)

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Polyureas have recently been shown to be effective coatings for protecting metals against penetration by high speed impacts.<sup>1,2</sup> It has been proposed that the mechanism of protection is the strain hardening of the polyurea layer which increases the effective modulus of the metal/polymer bilayer, thus dissipating more impact energy and resulting in a reduction of metal necking failure.<sup>3</sup>

To investigate this mechanism, three polyureas with decreasing soft segment molecular weights of 1000, 650 and a 250/1000 blend were molded onto mild steel circular plates and then impacted with a high speed (275 m/s) ogival steel impactor. The polyurea layer of the post mortem bilayers was characterized on a molecular level using SAXS at Argonne National Laboratory. Analysis shows that the hard domains of the polyureas with the lower molecular weight soft segments reformed and oriented over a greater area of the coating, thus increasing the polymer strain hardening and resulting in visibly less out of plane bilayer deformation. These results agree with the hypothesis that polymer strain hardening is a mechanism that can retard necking failure of the metal plate.

<sup>1</sup> W. Mock , E. Balizer, J. Fedderly, and G. Lee, "Penetration Protection of Steel Plates with a Polyurea Layer", ONR Workshop on Materials and Structures for Advanced Ship Protection, Airlie, VA, Aug. 2005.

<sup>2</sup> E. Balizer and W. Mock, Shock Wave Effects on Polymer Morphology, American Physical Society March Meeting, Baltimore, MD, March 2006.

<sup>3</sup> Z. Xue, J. W. Hutchinson, *Mechanics of Materials* **39**, 473-487 (2007).