

Impact Response of Materials: From Metals to Soft Gels

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The impact response of materials is of prime importance in a variety of scenarios that can involve structural destruction on the one hand, but also structural or bodily protection on the other. This presentation will address two different, yet complementary, aspects of the research carried out in the Dynamic Fracture laboratory at Technion.

Starting with metals, we will discuss the adiabatic shear failure of metals, as subject on which we have been working for some 15 years. While the classical paradigm explains adiabatic shear formation in terms of strain-rate sensitivity vs. thermal softening, we will present a different viewpoint in which local softening leading to the formation of a shear band (ASB) is not of thermal but rather of *microstructural* origin. Namely, we will show the early formation of dynamically recrystallized islands in the prospective locus of the future shear band. Those islands are stronger than the matrix surroundings on the one hand (Hall-Petch effect) but are also characterized by a lack of strain-hardening, causing local softening. In addition, local real-time temperature measurements using HgCdTe-IR detectors clearly shows that until the structural load collapse stage, the temperature rise is quite minor, and probably not of a sufficient extent to trigger significant thermal softening as commonly believed. The thermomechanical coupling-microstructure relationship will also be addressed. The outcome of those works points out to the microstructurally stored energy of cold work as a potential factor for a dynamic failure criterion related to adiabatic shear failure.

Turning next to impact energy mitigation, we will show results on thermo-reversible dilute aqueous Methyl Cellulose gels, when those liquid gels solidify upon heating as opposed to most known materials. The endothermic nature of the process, which has also been identified to occur under strong shocks, acts to absorb a significant part of the impact energy. Results will be shown about the extent of the impact mitigation that make those simple gels powerful candidates for future bodily (or other structural) protection in which one wants to mitigate the strong elastic accelerations that can be very damaging to internal organs.