SHOCK WAVE PROPAGATION IN HETEROGENEOUS LAYERED COMPOSITES

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Heterogeneous layered composites offer promise for mitigation of the effects due to impact/blast loading through scattering between dissimilar materials and thus promoting shock wave dissipation and dispersion. In the present work, steady plastic shocks generated by planar impact on metal-polymer laminate composites are analyzed in the framework of gradient plasticity theories. The laminate material has a periodic structure with unit cell composed of two layers of different materials. First and second order gradient plasticity theories are used to model the structure of steady plastic shocks. In both theories, the effect of the internal structure is accounted for at the macroscopic level by two material parameters depending upon the layer's thickness and the properties of constituents. Those two structure parameters are shown to be uniquely determined from experimental data [1].

Theoretical predictions of the model are compared with experiments for different cell sizes and for various shock intensities. In particular, the following experimental features are well reproduced by the modeling: (a) the shock width is proportional to the cell size and (b) the magnitude of strain rate is inversely proportional to cell size and increases with the amplitude of applied stress following a power law. For layered composite, the strain rate within the shock front increases by about square of the shock stress, while for many homogeneous metals it increases by the fourth power of the shock stress, indicating that layered composites have much larger shock viscosity due to the interface/microstructure scattering. While these results are equally described by both the plasticity theories, the first gradient plasticity approach seems to be favored when comparing the structure of the shock front to experimental data [1].

References

[1] S. Zhuang, G. Ravichandran and D. E. Grady, "An Experimental Investigation of Shock Wave Propagation in Periodically Layered Composites," *J. Mech. Phys. Solids*. **51**, 245-265, 2003.

Keywords: shock waves; composites; strain gradient plasticity