

The physics and mechanics of dynamic shear localization

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Dynamic shear localization, also known as adiabatic shear banding (ASB), is a frequently observed failure mechanism in dynamically loaded solids (crystalline and amorphous). ASB is traditionally considered as a material instability, and modeled consequently. Since the early days of Zener and Hollomon (1944), it is well established that ASB arises from the destabilizing competition between strain (rate) hardening and thermal softening, the latter ultimately prevailing at failure.

In this talk, we will present a completely different point of view, based largely on experimental work at various scales. It will be shown that the phenomenon is first of all related to the so-called dynamically “stored energy of cold work”, which implies in turn a direct connection with the material microstructure, and hence its deformation micromechanisms, as an alternative to the classical continuum approaches.

We will elaborate on those microstructural evolutions, with emphasis on dynamic recrystallization, twinning and their interaction.

Finally, ballistic perforation experiments and their modeling based on the above-mentioned concepts will be briefly presented, as an application of the above.