Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Stability of surface plastic flow in large strain deformation of metals KOUSHIK VISWANATHAN, ANIRDUH UDAPA, Purdue Univ, DINAKAR SAGAPURAM, Texas AM Univ, JAMES MANN, SRINIVASAN CHANDRASEKAR, Purdue Univ — We examine large-strain unconstrained simple shear deformation in metals using a model two-dimensional cutting system and high-speed *in situ* imaging. The nature of the deformation mode is shown to be a function of the initial microstructure state of the metal and the deformation geometry. For annealed metals, which exhibit large ductility and strain hardening capacity, the commonly assumed laminar flow mode is inherently unstable. Instead, the imposed shear is accommodated by a highly rotational flow—sinuous flow—with vortex-like components and large-amplitude folding on the mesoscale. Sinuous flow is triggered by a plastic instability on the material surface ahead of the primary region of shear. On the other hand, when the material is extensively strain-hardened prior to shear, laminar flow again becomes unstable giving way to shear banding. The existence of these flow modes is established by stability analysis of laminar flow. The role of the initial microstructure state in determining the change in stability from laminar to sinuous / shear-banded flows in metals is elucidated. The implications for cutting, forming and wear processes for metals, and to surface plasticity phenomena such as mechanochemical Rehbinder effects are discussed.

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Date submitted: 11 Nov 2016

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