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MESOSCALE DEFORMATION-INDUCED SURFACE ROUGHENING AS AN EARLY PRECURSOR OF PLASTIC STRAIN LOCALIZATION

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The key challenge for materials science and mechanical engineering is to predict plastic strain localization and fracture long before these processes become evident on the macro scale. Many efforts have been made to identify early precursors of plastic strain localization preceding fracture. In this paper we present an approach to early prediction of macroscale plastic strain localization from observations of deformation-induced surface roughening (DISR) on the mesoscale. Experimental and numerical investigations are performed to reveal a correlation between mesoscale surface roughness and local plastic strains in uniaxial tension. The analyses show that roughening intensifies on a larger scale when smaller length scale deformation mechanisms are exhausted. A dimensionless parameter is introduced to quantify mesoscale roughness patterns, which appears to be fairly sensitive to and well correlated with the local strain values. Particularly, it begins to increas.