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Patterning in stress: a new insight into the deformation behavior of polycrystalline materials PAMELA BURNLEY, University of Nevada, Las Vegas — The distribution of stress and strain in plastically deforming polycrystalline materials is widely observed to be heterogeneous and has so far evaded simple characterization. While elastic plastic and visco plastic self-consistent models (which assume that the Schmid factor governs slip) enjoy some success in predicting macroscopic behavior, the distribution of strain between constituent grains is not well predicted by the Schmid factor. This lack of correlation is caused by differences between the macroscopic stress state and the local stress state around each crystal due to the mechanical interactions of neighboring grains. Using 2D plane strain finite element models of large ensembles of grains, I show that the distribution of stress in a polycrystal forms patterns that are broadly reminiscent of those associated with phenomena that are governed by percolation theory. The pattern of stress transmission is related to the degree of heterogeneity in and statistical distribution of the elastic and plastic properties of the constituent grains in the aggregate. For a highly heterogeneous polycrystals, the patterns are similar to force chains observed in granular materials. For a more homogeneous polycrystal, the density of force chains is greater and the degree of stress concentration in them is less. Understanding stress patterning will be critical for linking the macroscopic rheology of polycrystalline materials to the single crystal elastic and plastic properties of their constituent crystals.

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