Theory of ductility: From brittle to superplastic behavior of polycrystals

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The plastic flow of a polycrystal is calculated assuming that no sliding does occur if the in-plane components of the shear stress acting on the common grain boundary of two grains are below a threshold stress ?c. Otherwise the grains slide with relative velocity proportional to the in-plane shear stress. The trace of the resulting strain rate tensor does not vanish for finite threshold stress, indicating that the grains of the material are increasingly compressed as the sample is being stretched. The internal pressure helps deformation, and under some precise physical circumstances the material becomes mechanically unstable. The effect is very sensitive to the material constants and can explain extreme brittleness or large ductility. The approach can be extended to amorphous materials.