Local microstructure and flow stress in deformed metals

The microstructure and flow stress of metals are related through many well-known strength-structure relationships based on structural parameters, where grain size and dislocation density are examples. In heterogeneous structures, the local stress and strain are important as they will affect the bulk properties. A microstructural method is presented which allows the local stress in a deformed metal to be estimated based on microstructural parameters determined by an EBSD analysis. These parameters are the average spacing of deformation introduced boundaries and the fraction of high angle boundaries. The method is demonstrated for two heterogeneous structures: (i) a gradient (sub)surface structure in steel deformed by shot peening; (ii) a heterogeneous structure introduced by friction between a tool and a workpiece of aluminum. Flow stress data are calculated based on the microstructural analysis, and validated by hardness measurement and 2D numerical simulations. A good agreement is found over a plastic strain range from ~1 to 5.

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