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Discrete Dislocation Calculations of the Stored Energy of Cold Work

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The stored energy of cold work is calculated for crystalline material samples where plastic deformation occurs through dislocation glide. Superposition is used to represent the solution of boundary value problems in terms of the infinite fields for discrete dislocations and image fields that enforce boundary conditions. Constitutive rules are used which account for the effects of 3D dislocation dynamics such as dynamic junction formation. At each deformation step, the stored energy, defined as the change in free energy with a change in dislocation positions at constant stress, can be explicitly calculated both under load and after load removal with the line energy contribution accounted for. The extent to which the energy stored in the sample depends on the deformation state is analyzed by considering plane strain tension and bending of a single crystal. The effects of crystal orientation and of the amount of supplied mechanical energy are also investigated.

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