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Investigation on Dislocation-based Plasticity in Submicron Scale Single Crystals

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Abstract: Dislocation-based plastic behaviors in submicron single crystals are widely observed in recent in-situ TEM tests. The micro-bars under compression and tension with diameter ranging from 200nm to 800nm are extensively investigated by the theoretical model and three dimensional discrete dislocation dynamic coupled with finite element method (3D-DDD/FEM). The dislocation starvation induced by the annihilation of dislocations from the free surfaces and the forest dislocation hardening induced by the multiplication of a large amount of dislocations are studied. The compression and tension tests of Cu and Al single crystal micro bars are simulated and experimented containing initial dislocation networks. The mechanical behaviors are investigated including dislocation pattern transitions, size-dependent flow stress evolution, strain hardening mechanisms and Bauschinger effect. Two main factors affecting the dislocation motion are taken into account, such as free surface interaction and dislocation junction.

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