ABSTRACT

We present dislocation simulations involving the collective behavior of partials and extended full dislocations in nanocrystalline (nc) materials. Although atomistic simulations have shown the importance of including partial dislocations in high strain rate simulations, the behavior of partial dislocations in complex geometries with low strain rates has not been explored. To account for the dissociation of dislocations into partials we include the full representation of the gamma surface for two materials: Ni and Al. Enhanced strain rate sensitivity in nc materials has been observed both in experiments and in atomistic simulations. This high strain rate sensitivity observed in nc and ultra-fine grained materials is believed to arise from a shift in rate-controlling mechanism from dislocation- to GB-mediated processes. We carry out dislocation dynamics simulations of nc metals under different strain rates. The predicted stress–strain curves show that the flow stress increases with strain rate. Furthermore, the investigation on dislocation densities of partial and extended full dislocations shows that the density of partial dislocations and staking faults increases considerably with increasing strain rate, although under quasistatic loading our simulations show no increase of the stacking fault density in deformed nc nickel.