Developing Atomic Resolved Mechanical Testing System and Measuring Grain/Twin Boundary Plasticity at Atomic Level

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How to characterize and measure the interface phenomena on the microscopic level is one of the most fundamental questions [1]. We report here the characterizing and measuring of plasticity properties of grain and twin boundaries at microscopic level, particularly at nano and atomic scale. Mechanical-thermal-electrical functional instruments are developed to accommodate the sub-A spatial resolution with time-resolved abilities [3]. By monitoring and measuring grain and twin boundaries' plasticity at atomic level, it is discovered that: large angle unsymmetrical tilt grain boundaries slide by intrinsic dislocations climb and extrinsic disconnection slide [4]. The interactions of sliding extrinsic disconnections with intrinsic GB dislocations creates dislocation locks. The unlock and re-lock processes of the interacted GB dislocation-disconnection pairs accommodate GB sliding by GB atom transfers. For the TB, dislocations pin, pile up and cross-slip are directly revealed and uncovered. Finally, we report a new nucleation route of deformation twin through alternated stacking faults to detour the extremely high twin fault energy in nano-crystalline Pt, which is in contrast to the classic layer by layer emission stacking fault route for twin nucleus.

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