Plastic Physics of Defect Mechanics

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【Outline of survey】

Basic mechanism of plastic deformation of the ductile materials should be reduced to the behavior of the line defect of dislocation. However, linkage to the macroscopic plasticity f such a basis might be achieved only if the huge number of defects can be managed and the extremely complicate interactions between the line and the line defects, or the line and the planar defects of surface and grain boundary can be fully understood. The present project aims at investigating and synthesizing such defect interactions using nanoindentation which can realize the almost ideal collective dislocation nucleation in the statistically defect-free region. Especially, the interaction of the emitted dislocations to the grain boundary is emphasized, which is key issue of the defect-controlled mechanics for enhancement of the materials strength. The properties of the displacement burst, which is the nanoscopic abrupt increase of the indent depth due to the collective dislocation emission, provide the various roles of grain boundary; piling-up of dislocation, absorption, or dislocation source. These are summarizing from the experimental mechanics for finding out the real interaction and also from the computational mechanics for tracing the defect dynamics.

【Expected results】

One of the recent demands to the engineering field is to design the safer and the more relieved structures to the natural and the artificial disasters, and also the structures with a log life to save the resources. The achievements of the present project are much expected to give the basic understanding of the fracture and the unstable finite irreversible deformation of the matters. It can cover the semiconductor field where only one line defect is never allowed for reliability and also the sheet metal forming process of the automobile where the continuous defect field should be fully specified for more precise prediction of plastic deformability.

【References by the principal investigator】

- Y. Shibutani, T. Tsuru and A. Koyama, Nanoplastic deformation of nanoindentation: Crystallographic dependece of displacement bursts, Acta Materialia, Vol.55, 2007, pp.1813-1822.
- Y. Shibutani and A. Koyama, Surface roughness on the displacement bursts observed in nanoindentation, Journal of Materials Research, Vol.19, No.1, 2004, pp.183-188.

【Term of project】 FY2008-2012	【Budget allocation】 89,700,000 yen (direct cost)

【Homepage address】 http://www-comec.mech.eng.osaka-u.ac.jp/