京都大学構造材料元素戦略研究拠点セミナー

日　時： 2012 年 10 月 5 日（金）13:30～15:00
場　所： 京都大学工学部物理系校舎（吉田キャンパス）
5 階材料工学セミナー室（527 室）

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講演題目: **KINETICS OF SCREW DISLOCATIONS IN Fe AND Fe ALLOYS AT LOW TEMPERATURES - IN-SITU TEM STUDY**

Abstract :

Pure iron exhibits a discontinuity in the temperature dependence of stress and activation volume, which indicates a possible change of mechanism at around 200-250K. This discontinuity has never been satisfactorily interpreted, in spite of many recent atomistic calculations. In addition, its vanishing upon alloying may help to understand the important corresponding softening and hardening effects. To interpret such behaviour, in situ experiments have been carried out first in pure Fe, between 110K and 300K. The videos show straight screw segments gliding and cross-slipping between {110} planes, where they are subjected to a high frictional stress. Two different kinds of kinetics are however observed as a function of temperature: - In the higher temperature range, close to room temperature, screw dislocations move steadily, as expected from a kink-pair mechanism. The close inspection of dislocation sources shows that they move at a velocity proportional to their length, in agreement with the corresponding model. Activation volumes have been measured at the scale of a single source. - In the lower temperature range, screw dislocations move jerkily. They remain locked in a Peierls valley during several seconds, then jump in a {110} plane over several tens of nanometers during less than 1/50 s, till they are locked again, and so on. The average jump length decreases at increasing temperature.
These different behaviours have been modelled and correlated to the activation parameters of the mechanical properties.

In a second part, the complex softening/hardening effects of solute atoms will be discussed. In situ experiments in Fe containing C, P, Si and Cr in various concentration, show that solute atoms strongly influence the kinetics of screw dislocations. The softening effect between 150K and 250K is interpreted by a shift of the steady-jerky transition to the lower temperatures. The hardening effect above 250K is attributed to the interaction between screw dislocations and solute atoms, which enhances the nucleation of a high density of superjogs. Preliminary results in the high-temperature domain of dynamic strain ageing (20°C-500°C) will also be presented.

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