On the Initial Stage of Plastic Deformation of $SrTiO_3$

Peter Paufler, André Belger, Beate Bergk, Dirk C. Meyer, Alexander Levin, *Chair of Crystallography, Institute of Structural Physics, Dresden University of Technology, D-01062 Dresden, Germany.* E-mail: paufler@physik.tu-dresden.de

Nanoindentation experiments have been performed on{100}-, {110}- and {111}- oriented single crystals at room temperature. Force-displacement curves F(h) showed pop-ins at F > 500μN. Their depth Δh varied between Δh = 1 ...20 (for {100} and {110}) or = 5 .... 40 nm (for {111}). They indicate the onset of plastic deformation and correspond to extreme strain rates of $20s^{-1}$. Connected with pop-ins, slip bands starting from the indent have been observed which are parallel to macroscopically active zones of slip planes {011} or{100}. They are also compatible with the slip direction <0-11> (cf. [1]). These bands propagate proportionally to both the depth of the indent and the contact pressure beneath the indenter. Extrapolating $\Delta h(\sigma) \rightarrow \Delta h = 0$ gives the following critical contact pressures p_c, when plastic deformation should set-in during increase of load. We found p_c/GPa = 19.0 (100), 20.0 (110), 23.00 (111) GPa for the three surface orientations (hkl), which are of the order of E/10. This stress level and the energy associated with a pop-in let us assume that spontaneous generation of dislocations occurs during a pop-in. Unlike macroscopic plastic deformation, which starts at a flow stress of 0.15 GPa [1], nanoindentation probes only part of the crystal $< d^3$ where no grown-in dislocations (average spacing d) will be encountered, hence stresses higher at 2 orders of magnitude are required.

[1] Brunner D., Taeri-Baghbadrani S., Sigle W., Rühle M., *J. Am. Ceram. Soc.*, 2001, **84,** 1161

Keywords: nanohardness, plastic deformation,dislocations