PHYSICS OF MATERIALS

Physics School Autumn 2024

Series 6 **1 November 2024**

Exercise 1 Density of dislocations and the Frank lattice

The dislocation density in a crystal is defined as the ratio between the total dislocation length and the crystal volume. The dislocations arriving at the surface of the crystal create local deformation (etch-pits) that we can observe. Knowing the average distance between each etch-pit, i.e., plastic deformation is uniform, we can calculate the density of the dislocations in the crystal.

In general, etch-pits are produced by screw dislocations. We observe the surface of an aluminum sample (1 cm^3) perpendicularly to the direction $[\bar{1}10]$, and we measure an average distance between etch-pits of 10 µm.

Calculate the maximum plastic deformation due to the movement of dislocations with Burgers vector $b = \frac{b}{2}[\bar{1}10]$ in the dense planes relative to this vector. We neglect dislocation sources. The lattice parameter of silicon is 5.43Å, and the atomic radius is 1.11Å.

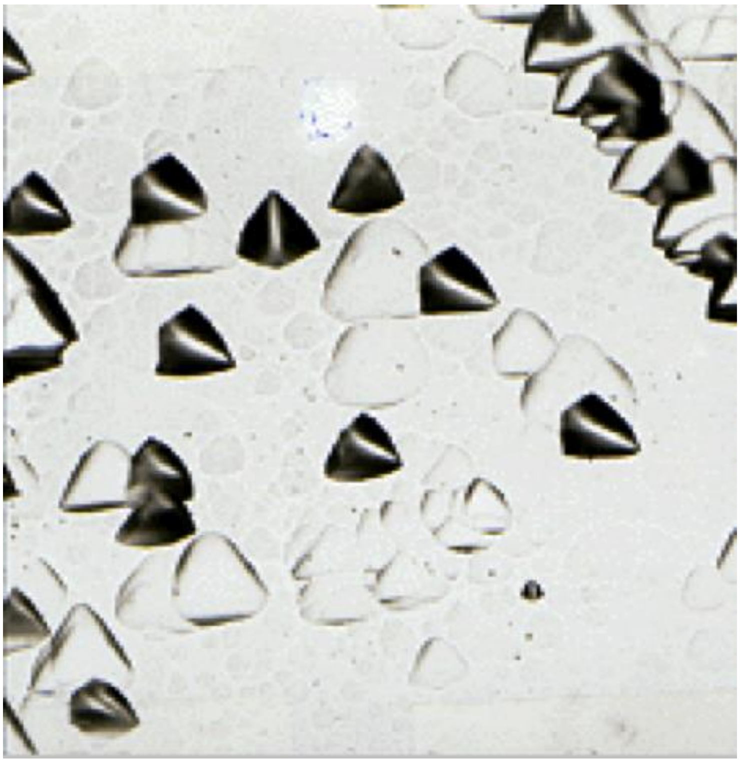

Figure 6.1 Etch-pits in silicon observed on a (111) plane
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Exercise 2 Nabarro-Herring creep

A cubic sample of dimension d is submitted to a constant tensile stress σ. Calculate the strain rate of the sample maintained at a constant temperature T due to the diffusion of the atoms (respectively of the vacancies) within the crystal.

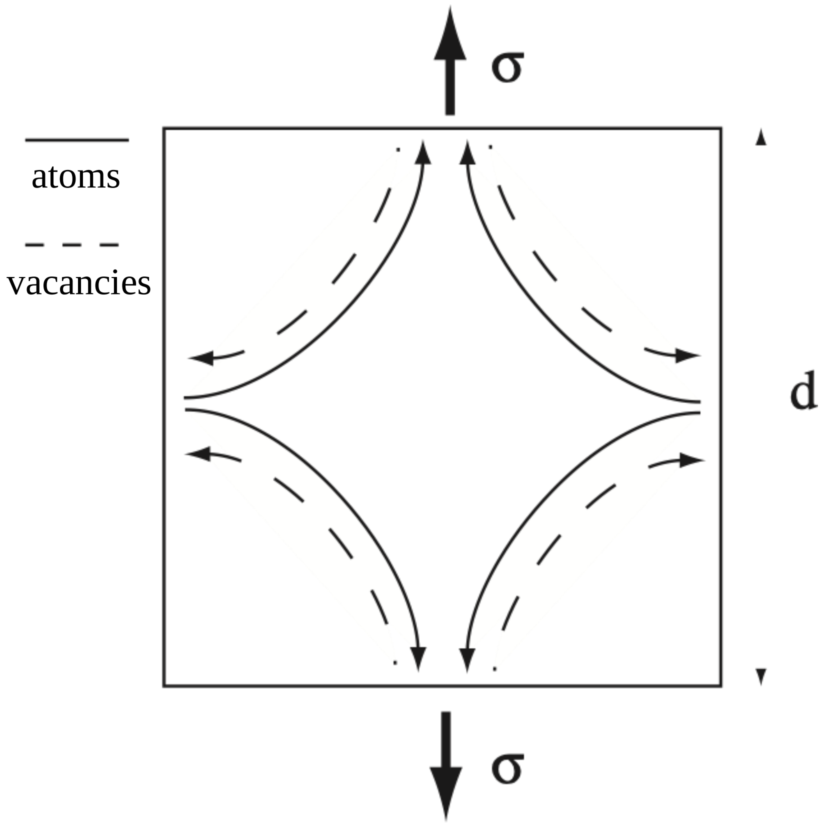

Figure 6.2 Scheme of the vacancy and atoms movement during creep