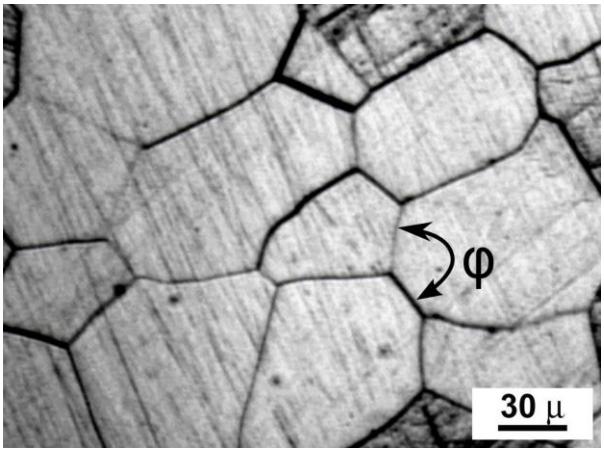
1. Inside a poly-crystal, there are numerous grains. What is interesting is that all the contact angles (φ) between two grains are usually very close to 2π/3. Can you explain why this is the case?



2. A small-angle tilt grain boundary can be described adequately by a vertical wall of dislocations.

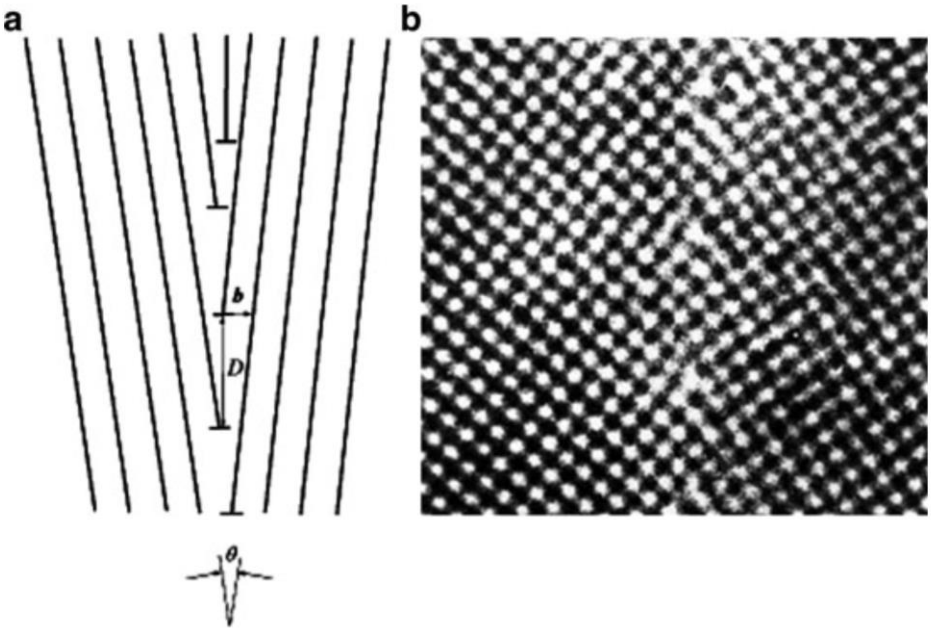


Figure 1: Schematic illustration and HRTEM image of [110] low-angle grain boundary in molydenum.

a) What is the average distance D between two dislocations? Given the angle of tilt θ and the lattice parameter b.

b) The energy of a low-angle grain boundary can be approximated by

$$\gamma_{gb} \approx E_{\perp}/D$$

Where $E_{\perp}$ is the energy cost of a dislocation, explain why this approximation will become more inaccurate when the tilt angle θ becomes larger.