Introduction
Large plastic deformation and texture evolution of polycrystal FCC metals is modeled using single and bi-crystals as RVEs for the crystal cores and boundaries, respectively:

**Enhanced hardening**
*Nye’s dislocation tensor* is determined using the plastic deformation difference:

$$\Lambda \sim \nabla \times F_p = n \times \frac{\Delta F_p}{l}, \quad \Delta F_p = F^\text{int}_p - F^\text{core}_p$$

Using the alternative expression for $\Lambda$, the GND densities are determined by minimization of $|\rho_G|$ [2]:

$$\Lambda = \sum_\xi \rho^G_G \kappa^G_\xi \kappa_\xi, \quad \xi = 1, \ldots, 18$$

Taking into account the dislocation interactions, the (additional) GND slip resistance contribution is computed, which is assigned to the bi-crystal.

**Results**
As a result of the introduced scale-dependency, the predicted material response agrees with the Hall-Petch relation, with a coefficient of $\frac{1}{2}$:

$$\bar{\sigma}(\bar{\varepsilon}) = \bar{\sigma}_0(\bar{\varepsilon}) + K(\bar{\varepsilon}) d^{-\frac{1}{2}}$$

**Conclusions**
The advantages of this intermediate model are:

- In contrast to the Taylor and Sachs model, compatibility and equilibrium are (locally) enforced.
- The possibility to include the crystal size in the formulations without *explicitly* using a flow stress relation to accomplish this.

**References:**