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Grain boundary interface model in strain gradient crystal plasticity

P.R.M. van Beers, V.G. Kouznetsova and M.G.D. Geers



Introduction

Grain boundaries (GB) play an important role in metallic materials in defining their strength, reliability and life time properties, e.g. in MEMS (Fig. 1).

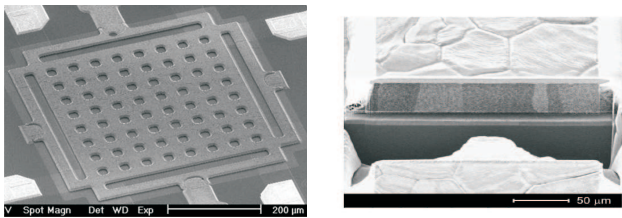


Figure 1: A metallic MEMS (left) and its grain structure (right).

At present, GB modelling lacks the critical interaction between plasticity and interfaces, which takes place at the level of individual dislocations. A better insight and quantification of the mechanisms at interfaces can only be gained through detailed analysis of these processes across different length scales: from the molecular dynamics (MD) level (TUD) via the discrete dislocations dynamics (DDD) level (RuG) to the continuum interface level (TU/e) (Fig. 2).

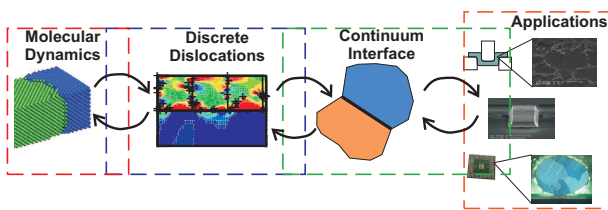


Figure 2: Scales and scale transitions up to the application level.

Experimental observations, e.g. [1], indicate that dislocations can be accumulated, transmitted, absorbed or nucleated at interfaces (Fig. 3).

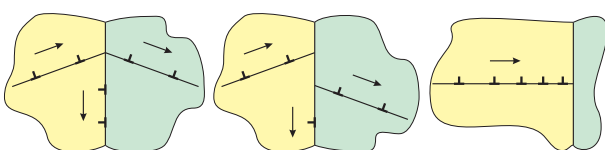


Figure 3: Interaction of dislocations with grain boundaries.

Conventional modelling approach

At the polycrystalline continuum scale, conventional modelling of interfaces in gradient enhanced crystal plasticity frameworks, e.g. [2,3], only allows to incorporate the limiting situations of either impenetrable (no slip) or infinite sink (free) GBs (Fig. 4).

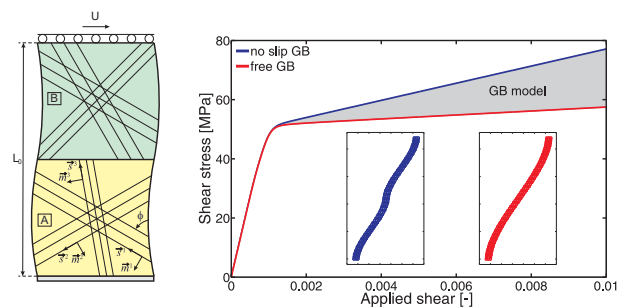


Figure 4: Bicrystal in shear (left) and GB interface conditions (right).

Enhanced interface model

The future goals are (1) to develop a GB model by means of thermodynamically consistent constitutive equations for plasticity through interfaces (Fig. 5) and (2) to use a multi-scale approach to define constitutive rules emanating from the interactions of discrete dislocations from MD and DDD analyses.

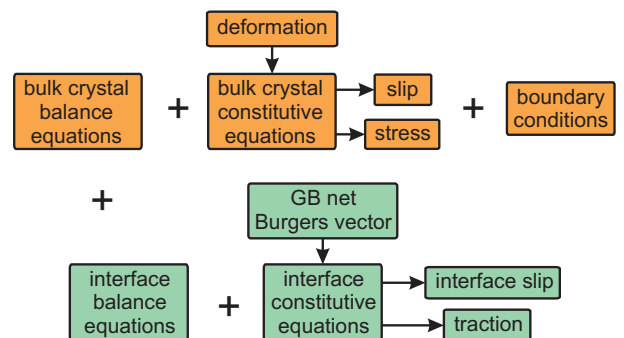


Figure 5: Schematic of enhanced framework under development.

References

- [1] T.C. Lee et al., 1990, *Metall. Trans.* 21A, 2437.
- [2] L.P. Evers et al., 2004, *J. Mech. Phys. Solids* 52, 2397.
- [3] C.J. Bayley et al., 2006, *Int. J. Solids. Struct.* 43, 7268.