Strain gradient plasticity modelling of twinning in TWIP steels

Rohith B. Ravish*, Peter Z. Berke† and Thierry J. Massart†

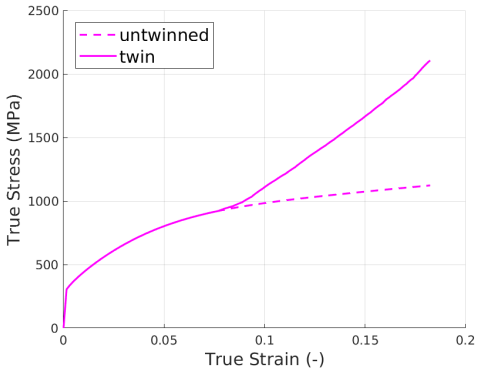
* Building, Architecture and Town Planning CP 194/2
Université libre de Bruxelles (ULB)
Avenue F.D. Roosevelt 50, 1050 Brussels, Belgium
e-mail: rbelurra@ulb.ac.be, web page: http://batir.ulb.ac.be

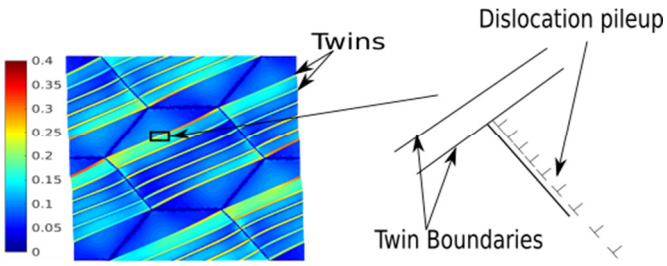
ABSTRACT

It is well known that twinning Induced Plasticity (TWIP) is a mechanism used to enhance the work-hardening of certain metals by inducing a change in their microstructure [1]. From a phenomenological viewpoint, the appearance of a twin inside a grain may be seen as the addition of an interface preventing dislocation glide.

The objective of this contribution is to study the TWIP effect computationally, using strain rate independent Strain Gradient Plasticity (SGP) [2]. The plastic strain gradients induced by appearing twins, forming new boundaries to plastic straining, impact on macroscopic stress strain response of the material. In this study twins are considered to be dynamically appearing hard phases and are introduced at specific macroscopic strain levels obtained from experimentally observed twin volume fraction evolution as a function of the applied macroscopic strain. The properties of the microstructure are updated to account for the effects of twinning.

The interactions between the internal length scale assumed for the gradient continuum and the other characteristic lengths (twin spacing, twin width, …) are investigated. A parametric study is presented to calibrate the value of the internal length scale allowing to reproduce the overall mechanical response of the material.





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[2] N.A. Fleck, J.W. Hutchinson, A reformulation of strain gradient plasticity, Journal of the Mechanics and Physics of Solids, **49(10)**, 2001.