Asociación Argentina de Mecánica Computacional

Mecánica Computacional Vol XXXIX, págs. 1153-1153 (resumen)
F.E. Dotti, M. Febbo, S.P. Machado, M. Saravia, M.A. Storti (Eds.)
Bahía Blanca, 1-4 Noviembre 2022

IRRADIATION HARDENING OF REACTOR PRESSURE VESSEL STEELS: CRYSTAL PLASTICITY LAW AND POLYCRYSTAL FULL-FIELD SIMULATIONS

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Keywords: irradiated RPV steel, crystal plasticity, polycrystal, Fast Fourier Transform based method

Abstract. The context of this work is relative to the aging of vessel steels in pressurized water reactors. Due to irradiation, microstructural changes occur in these reactor pressure vessel (RPV) steels. They are the key to understand and predict the modification of the viscoplastic responses of these steels (including the so-called "irradiation hardening") and their fracture properties with irradiation. Recently, a new physically based crystal plasticity law, derived from Monnet et al. (*J Nucl Mater*, 514:128–138 (2019)), has been proposed to describe the viscoplastic behavior of neutron irradiated RPV steels. The constitutive equations have been developed from molecular and dislocation dynamics results. To ensure the validity of this new crystal plasticity law, numerical simulations have been carried out on polycrystalline microstructures, for a range of temperatures and irradiation doses. These numerical simulations have been performed using the CraFT computer code, based on a Fast Fourier Transform method (FFT based method (Moulinec and Suquet, *Comp Meth Appl Mech Engng*, 157:69–94 (1998)). The representative volume element is a polycrystal composed up to 512 grains, whose orientations have been selected by following a Sobol sequence to mimic an isotropic polycrystal while optimizing the number of grains. The different results obtained were in good agreement with experimental data.