Effect of crystallographic texture on deformation and fracture in commercially pure titanium

Vivek Kumar Sahu , Manasij Yadava , Pritam Chakraborty , and Nilesh Gurao*[1]

[1]Indian Institute of Technology [Kanpur] – India

Abstract

Commercially pure titanium (CP-Ti) with a hexagonal close packed structure is characterized by anisotropy in mechanical properties like yield strength, ultimate tensile strength, and ductility for different initial textures. In the present investigation, we show that the level of anisotropy is further accentuated in the presence of different levels of stress triaxialities leading to higher anisotropic mechanical properties in the presence of notch as well for J-integral value for fracture toughness in CP-Ti. A combinatorial experimental and computational approach has been employed to establish the micro-mechanisms of deformation contributing to this unique behaviour. Full-field 2D strain measurement using digital image correlation and in situ EBSD, as well as mean-field viscoplastic self-consistent simulations and full-field crystal plasticity finite element method simulations, have been used to establish the operative deformation and damage micro-mechanisms. The critical role of deformation twinning in the presence of stress triaxiality in determining the deformation, damage, and fracture behaviour will be established. The fidelity of the combinatorial multi-scale experimental and computational approach adopted in the present study to provide better insight into the deformation and damage processes in CP-Ti will be deliberated.

Keywords: anisotropy, deformation, damage, twinning, titanium

*Speaker