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Cracks within gradient micropolar elasticity

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ABSTRACT

Generalized continuum mechanics successes in capturing features that cannot be addressed in a classical continuum theory. In fact, generalized continua is an attempt to bring the continuum modelling prediction and the architectured structure or discrete material behaviour closer. Considering the phenomenon, appropriate generalization needs to be employed.

In line with developing the generalized continuum theories for perfect materials, a generalized fracture theory needs also to be established. Interestingly the classical singularity of dislocation cores or crack tips are regularized in a number of generalized continua. Further, crack tip plasticity can also be captured without any assumption of cohesive zone. Although the singular fields of defects have been taken care of carefully in the classical fracture theory, e.g. by introducing the stress intensity factor, one may criticize the existence of these singularities. Besides, the classical stress intensity factor fails to describe fracture below a critical singular field of 2–3 nm, i.e. the breakdown of continuum fracture mechanics at small scales [1]. These observations motivate the generalization of the classical fracture theory for, in this case, nano-scale.

A dislocation-based approach serves well towards modelling cracks based on a well-established literature of dislocation mechanics. The dislocation-based fracture theory has been developed earlier within a number of generalized continuum theories including couple-stress elasticity [2], isotropic and anisotropic Helmholtz-type nonlocal elasticity [3,4], gradient elasticity [5], and bi-Helmholtz type nonlocal and gradient elasticity [6]. In this presentation, the dislocation-based micropolar elastic fracture theory and extensions to gradient micropolar elasticity will be discussed.

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