Abstract:
Dislocations play a key role in fracture and plasticity of crystalline materials. In line with this observation, within continuum mechanics, the dislocations are interpreted as the building blocks of cracks in fracture mechanics and also are known as the carriers of plasticity. A unified dislocation-based theory for plasticity and fracture is an ambitious long-standing goal.
The equivalence of a crack and a continuous distribution of dislocations was already recognized in the 1970s and earlier. Accordingly, the stress field of cracks may be calculated as a convolution of the stress field of dislocations with a so-called dislocation density function. This approach is well stablished as “dislocation-based fracture mechanics” or “distributed dislocation technique” for crack problems in classical elasticity.
Second strain gradient theory regularizes all classical singularities of the classical dislocation. Considering this interesting aspect of the second gradient elasticity, the dislocation-based fracture mechanics is formulated within this framework. The resulting formulation provides a fully nonsingular fracture theory. Furthermore, crack tip plasticity is captured without considering any cohesive force.