

## ABSTRACT

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### On Gradient Plasticity: A 2025 Update

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A brief review of gradient plasticity theory is given as first proposed by the author in 1984 and further elaborated upon by him and co-workers till today; subsequently provided a different formulation by Fleck, Hutchinson et al. in 1984-2001, whose consistency with thermodynamics was examined by Gurtin and Anand in 2009; and more recently enhanced with stochasticity and fractionality aspects [1-2]. Related contributions by Gao/Huang/Nix/Hutchinson and co-workers (in late 1990s) are also mentioned. Surface effects as first introduced by Katerina Aifantis/Willis and Gudmundson in 2004, along with subsequent important advances by Voyiadjis and co-workers (e.g. the books in 2019, 2020) are outlined. Key-contributions to the field (Muhlhaus, de Borst, Vardoulakis, Zbib, Steinmann, Forest and Polizotto) on numerical and thermodynamical aspects are also mentioned. Since dislocations are the carriers of plastic deformation, an account of gradient dislocation dynamics is given as first proposed by the author in 1984; subsequently elaborated upon by Walgraef and Aifantis (the W-A model for dislocation patterning) and others (for a most recent overview, see [3]); and finally motivated the development of current numerical codes based on discrete dislocation (DD) and continuum dislocation (CD) dynamics. All other references mentioned above can be found in the bibliography of [1-3].

#### References

1. E.C. Aifantis, Internal length gradient (ILG) material mechanics across scales & disciplines, Adv. Appl. Mech. 49, 1-110 (2016).
2. E.C. Aifantis, Gradient Extension of Classical Material Models: From Nuclear & Condensed Matter Scales to Earth & Cosmological Scales, Springer Tracts in Mechan. Engng., pp. 417-452 (2021).
3. E.C. Aifantis, Morphogenesis in plasticity: gradients, dislocation patterns & deformation bands – a personal view – in recognition of Nasr Ghoniem's research contributions, J. Mater. Sci. (in press).