Challenges and achievements in nonlocal mechanics of nanostructures

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Modelling, design and optimization of advanced materials and ultrasmall structures is nowadays a topic of major interest for the scientific community in light of the recent progresses of Nanoscience and Nanotechnology. Smaller and smaller smart electromechanical devices such as sensors, actuators, resonators and energy harvesters, are rapidly developing research fields with several challenging applications ranging from Nanoengineering to Biomechanics. Nanomaterials, such as graphene platelets and carbon nanotubes, are quickly spreading as effective tools for realization of new generation devices and improvements of composite structures. It is well acknowledged that modelling of innovative materials and nanosystems requires proper assessment of scale phenomena. Atomistic approaches accounting for discrete nature of matter, turn out to be onerous from the computational point of view. Alternative strategies accounting for size effects made recourse to Nonlocal Continuum Field Theories with still open questions concerning mathematical consistency and well-posedness of structural problems. Key aspects are validation of theoretical formulations by experimental results as well as assessment of length scale parameters. This lecture is aimed at providing an up-to-date description of nonlocal continuum approaches and of challenges regarding theoretical formulations and effectiveness in accounting for scale phenomena. Significant achievements and recent contributions to nonlocal continuum modelling of nanostructures are illustrated and discussed.