Effects of configurational forces on elastic structures: torsional locomotion and self-encapsulation of an elastic rod

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Bigoni et al. (2014) [1] have shown that 'Eshelby-like' forces act on a structure when it can change its configuration during a loading process. For example, an axial force can be generated when a rod is constrained with a (smooth and bilateral) sliding sleeve, a nonstandard constraint which permits the change in length of the rod. The action of these forces on elastic structures leads to several 'unexpected' mechanical behaviours, in particular two examples are presented. Propulsion by means of flexural/torsional deformation. When an elastic rod is confined into a perfectly smooth channel, its motion (namely, a longitudinal propulsion) is realized to achieve a minimum in the elastic energy (Fig. 1, left); Self-encapsulation of a rod. A rod covering a fixed span and loaded transversally can exhibit 'self-encapsulation' when a 'dripping' point is reached (Fig. 1, right). These phenomena, strictly related to configurational mechanics and unrealizable in presence of only 'standard' constraints, are theoretically shown and experimentally proven. The above-mentioned results open new perspectives in several fabrication technology, for instance related to drug delivery systems, optical devices, and sensors.

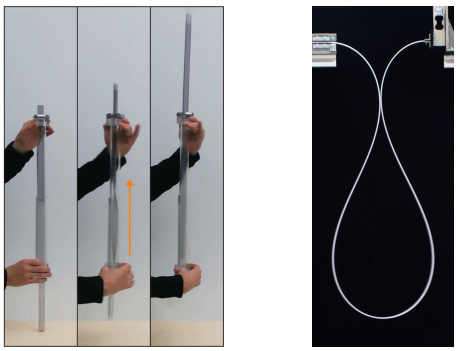

Fig. 1: Two applications of configurational mechanics: (left) the torsional gun showing longitudinal propulsion generated through a torque; (right) the self-encapsulation of an elastic rod.

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References

[1] D. Bigoni, F. Dal Corso, F. Bosi, D. Misseroni, 'Eshelby-like forces acting on elastic structures: theoretical and experimental proof', *Mechanics of Materials*, **80**, 368-374. doi: http://dx.doi.org/10.1016/j.mechmat.2013.10.009