20th European Mechanics of Materials Conference - EMMC20
Florence, Italy | May 27th-29th, 2026
www.emmc20.unifi.it

Liquid crystals, poroelastic media and wrinkles: some theoretical and numerical results

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Paper ID: 52
Symposium S7: Mechanics of soft materials and structures

Abstract

Soft materials are widely present in both biological structures and technological applications. Approaches that combine both a theoretical analysis and numerical results allow us to provide a more complete and realistic treatment. I will briefly discuss three problems with a non-trivial interaction between two contributions from two different scales or parts of a system. In the first problem [1, 2], we theoretically proved, in accordance with numerical evidence, the existence of an equilibrium configuration for a nematic film with surface tension [3, 5] using the Calculus of Variations. In the second one [6], we derived the equations of Biot's poroelasticity from the microstructure in the case of incompressibility of both an isotropic, linear elastic solid and a low Reynolds' number Newtonian fluid flowing through its pores. By using the asymptotic homogenization technique, we obtain a macroscale system of PDEs, with corresponding cell problems at the pore-scale; moreover, we retrieve the equivalence between the change in volume of the porous solid and the volume of fluid exchanged. Finally, in the third case [4], we used incremental elasticity to analyze the surface instabilities of a bilayered cylinder with a thin coating that undergoes a uni-axial tension [7]. This analysis depends on the Poisson ratio of the coating and its shear ratio and it is supported by numerical simulations and complemented by some experimental tests.

Keywords:

Wrinkles Asymptotic homogenization Liquid crystals Calculus of variations Incremental elasticity

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