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Editorial

Foreword to the Special Issue on instability and bifurcation in materials and structures

In recent years, soft materials and flexible structures with unusual and fascinating properties have increasingly become the focus of promising applications in many areas of science and engineering, ranging from biology, micro- and nano-electro-mechanical systems, soft robotics, and flexible devices, to aerospace and civil engineering. A common characteristic of these materials and structures is their very low stiffness in at least one direction. They may thus experience large deformations under external stimuli, which often can go as far as to trigger structural instability. Their modes of instability usually involve changes in morphology and the formation of surface patterns across length scales that are much more complex and sophisticated than those in traditional hard materials and structures. These changes in morphology and shape are closely linked to function and capabilities, and they can be harnessed for applications in, for example, wrinkle-driven surface renewal and antifouling, shape and texture morphing of camouflaging skins, or micro- and nano-scale surface patterning of optical and electrical devices. Understanding how such instabilities arise and evolve, often into multiple bifurcations, is essential to predict, and ultimately, design complex materials and structures in modern industry. Making progress in that area requires advanced theoretical, computational, and experimental approaches. Much headway has been made, especially from the start of this century.

This Special Issue aims to stimulate this inter-disciplinary effort further, by bringing together a collection of papers dealing with different aspects of the instability mechanics of soft materials and structures, including thin films, biomembranes and slender structures. Another goal is to promote fundamental understanding and quantitative prediction of highly nonlinear deformations. Finally, the Special Issue aims to highlight diverse engineering applications.

The Special Issue collects 16 expert contributions addressing the theoretical, experimental, and computational aspects of this vibrant research field, on topics ranging from buckling and post-buckling of compressed hyperelastic columns, to film–substrate and core–shell systems under multiple stimuli such as mechanical, electric and magnetic fields, to buckle-delamination and ridge cracking of soft films on rigid foundation, to wrinkling mode transitions in stretched-twisted strips and fiber-reinforced sheets, growth-induced pattern formation in tubular or spherical tissues and gels, cavitation in compressible soft solids and elastomeric syntactic foams, and frequency bifurcation-based characterization of mechanical properties of nanomaterials.

We hope that these articles will encourage further discussions and foster diverse perspectives on this exciting field which has been growing tremendously fast in the past 20 years. We are in no doubt that they will substantially deepen our fundamental understanding of the nonlinear instability and bifurcation behaviors in materials and structures and also lead to the development of advanced models and methods.

We are most grateful to all the authors who have contributed to this Special Issue with their excellent work, and to the Editor-in-Chief, the Elsevier support staff, and the anonymous reviewers for their effort and time bringing this Special Issue to fruition.

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