Tunable mechanics of bioinspired adaptive fibrillar materials with transient crosslinking and entanglement

Marco Pensalfini*†[1,2] and Marino Arroyo[2,3,4]

[1]Queen Mary University of London – United Kingdom
[2]Universitat Politecnica de Catalunya – Spain
[3]Institute for Bioengineering of Catalonia [Barcelona] – Spain
[4]Centre Internacional de Mètodes Numèrics en Enginyeria – Spain

Abstract

Animal cells and tissues adapt their mechanical properties by combining cytoskeletal networks with widely different characteristics. Short, crosslinked actin filaments can turn over rapidly and develop active tension, controlling cell mechanics at moderate strains, whereas long, physically entangled intermediate filaments (IFs), which lack motors or long-lived crosslinks, control the large strain behavior (1). Intriguingly, double-network microstructures have also been key to enable realization of hydrogels with remarkable mechanical properties (3).

We have recently shown that entanglement-mediated self-organization provides corralled tangles inspired by epithelial IF networks with extremely non-affine and non-linear mechanics (2). However, in actual cells, the reorganization of IFs is hindered by interactions with the actin cytoskeleton or the nucleus. As a result, depending on the inter-network interactions and their time scale, cells can adapt their emergent mechanics by switching between affinity – mediated by crosslinking – and extreme non-affinity/non-linearity – mediated by entanglement. In this talk, we will discuss the mechanics of epithelial cells under stretch in terms of minimal models of interacting cellular components, identifying the building principles of such living materials and anticipating their translation into artificial adaptive materials.

References

(1) Latorre et al., Nature 563, 2018.

(2) Pensalfini et al., Phys Rev Lett 131, 2023.

(3) Sun et al., Nature 489, 2012.

*Speaker
†Corresponding author: m.pensalfini@qmul.ac.uk