UNIMORE
UNIVERSITÀ DEGLI STUDI DI
MODENA E REGGIO EMILIA

Dipartimento di Eccellenza | Fisica Torino

Dr. Federico Bosia:

BIOINSPIRED ADHESION

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Room 1.7 (ex room A)
Physics Building – via G. Campi 213/a, 41125 Modena

Abstract

There are many examples of natural materials achieving exceptional mechanical properties, including spider silk, limpet teeth, beetle armours, or lotus leaves, to cite only few examples. Thus, bioinspired approaches can be pursued to mimic natural (usually hierarchical) materials and design novel synthetic ones with superior mechanical properties, artificially emulating the way Nature fabricates materials. In the case of biological adhesion, animals like geckos display remarkable adhesive properties. This is linked to the complex structural features in the way the contact is subdivided in a hierarchical, tree-like manner, and the interplay between contact size and hierarchical organization in the detachment-sliding process.

To describe the physical mechanisms at play, a review of single and multiple peeling theories is provided and extended to study the influence of hierarchical fibrillar architectures on the load distribution at the interface with the substrate, and the corresponding detachment behaviour. A generalized adhesion scaling scheme for hierarchical structures is provided, proving the beneficial effect of multiple hierarchical levels. The effect of deformable, curved and patterned surfaces is also discussed. Further, the interplay between delamination and fracture is analysed in fibrillar attachment systems, such as those used in spider web anchorages. The resulting mechanical properties emerge from the complex interplay between mechanical and geometric parameters, including tape stiffness, adhesive energy, attached and detached lengths and peeling angles, which determine the occurrence of elastic deformation, interface delamination and tape fracture. Finally, the adhesive behavior of elastic membranes is examined, generalizing the results for tape multiple peeling and highlighting the role of the “peeling line”. Results are discussed in terms of potential for bioinspired applications.

Host
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