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ENVIRONMENTALLY CONTROLLED MODULUS MAPPING OF BIOCOMPOSITE MATERIALS EMPLOYING THE CONCEPT OF EFFECTIVE MASS

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Living organisms are known to form a large variety of mineral-organic composite structures with mechanical properties that combine high stiffness, strength, toughness and perform at different levels of relative humidity (RH). Usually, the organic components are spatially limited to sub-micrometer features and are confined by a much stiffer mineral material. Mechanical characterization of these organic features, whose properties are strongly influenced by RH, presents a real technical challenge. In the present work we demonstrate our ability to measure environmentally dependent static and dynamic mechanical performance of 1 µm thick organic films in the prismatic layer of the mollusc shell *Pinna nobilis* employing the nanoscale modulus mapping technique. Two recent developments were utilized during the mechanical characterization process: (1) Environmental control during measurements enabled us to perform the modulus mapping in RH ranging from 0 to 98% [1]; (2) The concept of effective mass of the nanoindenter tip/sample configuration enabled us to account for drastic changes in elastic properties of the organic phase with increasing RH [2]. The possibilities and the limitations of this methodology with regards to structural and mechanical properties of the studied prismatic microstructure in the shell will be discussed.

[1] L. Bertinetti, U. D. Hangen, M. Eder, P. Leibner, P. Fratzl and I. Zlotnikov, “Characterizing moisture-dependent mechanical properties of organic materials: humidity controlled static and dynamic nanoindentation of wood cell walls”, Phil. Mag. doi: 10.1080/14786435.2014.920544 (2014).
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