Probing mechanical properties of polydimethylsiloxane (PDMS) micropillars and alligator teeth

Matty Sey

Mechanical Engineering, Florida International University, Miami, FL 33174
* Mentor and co-mentor: Arvind Agarwal and Lihua Lou, Mechanical and Materials Engineering, Florida International University, Miami, FL 33174

Mechanical properties are essential to quantitatively characterize materials' intrinsic properties ranging from soft to rigid scales. It can effectively facilitate optimal material selection corresponding to their practical applications. Unlike mesoscale, microscale mechanical properties measure localized structural and fundamental components, which is especially superior for assessing materials with hierarchical or ultrastructural properties. This study aims to characterize localized mechanical properties of soft and hard materials: engineering polydimethylsiloxane (PDMS) micropillars and alligator teeth. The stiffness of PDMS pillar arrays is designed by the solvent-casting method, a raw input parameter to calculate the twitch force of cardiac microtissues. The microstructure-associated mechanical properties of alligator teeth will provide crucial information on designing abrasion-resistant toughening materials. Nanoindentation tests were conducted using 50 µm conospherical and 100 nm Berkovich probes. An endoscope camera was used to detect probe-surface contact and capture the indentation process. Hertz and Oliver-Pharr models were applied to analyze stiffness and elastic modulus. The results demonstrated the stiffness of micropillars was 3.4 – 5.45 N/m. It also indicated a high structural-mechanical relationship for alligator teeth samples. This study reveals the fundamental role of the nanoindentation technique in reviewing micromechanical properties and localized deformation behavior.

Keywords: micromechanical properties, nanoindentation, PDMS micropillars, alligator teeth, structural-mechanical relationship