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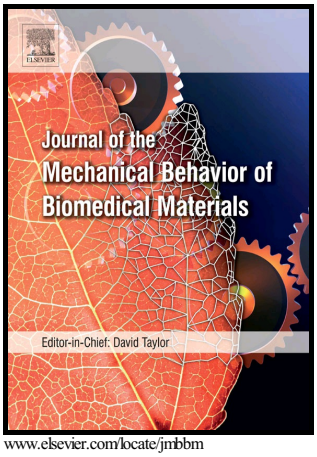

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Investigation of micromechanical properties of hard sphere filled composite hydrogels by atomic force microscopy and finite element simulations

Guanlin Tang[1,2], *Massimiliano Galluzzi*[1,2], *Chandra Sekhar Biswas*[1,2], *Florian J. Stadler*[1,*]

[1]College of Materials Science and Engineering, Shenzhen Key Laboratory of Polymer Science and Technology, Guangdong Research Center for Interfacial Engineering of Functional Materials, Nanshan District Key Lab for Biopolymers and Safety Evaluation, Shenzhen University, Shenzhen, 518060, People's Republic of China

[2]Key Laboratory of Optoelectronic Devices and System of Ministry of Education and Guangdong Province, College of Optoelectronic Engineering, Shenzhen University, Shenzhen, 518060, People's Republic of China

[*]Correspondence: Professor Florian J. Stadler,

E-mail: fjstadler@szu.edu.cn

Abstract

Atomic force microscopy (AFM) indentation is the most suitable way to characterize micromechanical properties of soft materials such as bio tissues. However, the mechanical data obtained from force-indentation measurement are still not well understood due to complex geometry of the bio tissue, nonlinearity of indentation contact, and constitutive relation of hyperelastic soft material. Poly-N-isopropyl acrylamide (PNIPAM) filled with 5 wt. % polystyrene (PS) sphere particles material system can be utilized as a simplified model for mimicking a whole host of soft materials. Finite element model has been constructed to simulate indentation as in AFM experiments using colloidal probes for a parametric study, with the main purpose of understanding the effect of particles on overall behavior of mechanical data and local deformation field under indentation contact. Direct comparison between finite element simulation and indentation data from AFM experiments provides a powerful method to characterize soft materials properties quantitatively, addressing the lack of analytical solutions for hard-soft composites, both biological and synthetic ones. In this framework, quantitative relations are found between the depth, at which the particle was embedded, the particle size and the elastic modulus of the overall composite.