Microscale Modeling of Damage and Fracture of Nacre

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ABSTRACT

The microstructure of nacre consists of polygon-shaped aragonite mineral tablets bonded by very thin layers of organic materials, and is organized in a brick-mortar morphology. In this research, three dimensional models based on the discrete element method (DEM), including volumes much larger than unit cells were developed to investigate damage and crack propagation mechanisms of nacre at the microscale. The aragonite mineral tablets were modeled with different shapes of three dimensional polygon particles generated by the Voronoi tessellation method to represent the voronoi like patterns of mineral tablets assembly observed in experiments [1]. The organic matrix was modeled with a group of spring elements. The constitutive relations of the spring elements were inspired from the experimental results of organic molecules from the literature [2]. The mineral bridges were modeled with simple elastic bonds with the parameters based on experimental data from the literature [3]. The models investigate the effects of mineral bridges, organic matrix and three dimensional microstructure architecture on the damage and crack propagation mechanisms of nacre, providing insight into the design of nacre-inspired materials.

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