Hierarchical structure observation, size effect characterization and trans-scale modeling for biomaterials

Yueguang Wei*, Jingru Song, Cuncai Fan

LNM Institute of mechanics, Chinese academy of sciences, Beijing 100190, China

*Presenting author and Corresponding author: ywei@LNM.imech.ac.cn

Abstract

In the present research, hierarchical structure observation and mechanical property characterization for a kind of biomaterial are carried out. The investigated biomaterial is *Hyriopsis cumingii*, a typical limnetic shell, which is consisted of two different structural layers, the prismatic "pillar" structure and the nacreous "brick and mortar" structure. The prismatic layer looks like the "pillar forest" with variation-section pillar sized in several tens of microns. The nacreous material looks like a "brick wall" with brick sized in several microns. Both pillar and brick are composed of the nanoparticles. The mechanical properties of the hierarchical biomaterial are measured by using the nanoindentation test. Hardness and modulus are measured for both the nacre layer and the prismatic layer, respectively. The nanoindentation size effects for the hierarchical structural materials are investigated, experimentally. The results show that the prismatic nanostructured material has the higher stiffness and hardness than the nacre nanostructured material. In addition, the nanoindentation size effects for the hierarchical structural materials are described theoretically, by using the trans-scale mechanics theory considering both strain gradient effect and the surface/interface effect. The trans-scale modeling results are well consistent with experimental ones.

Keywords: Biomaterial; Hierarchical Structure; Mechanical Property; Nanoindentation Size Effect; Trans-Scale Mechanics