Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

Investigation into the environment and temperature dependent nanomechanical properties of the shallow water shrimp (*Penaeus* spp.) exoskeleton

Verma, Devendra; Tomar, Vikas, Purdue University, West Lafayette, United States

ABSTRACT

This investigation focuses on understanding the influence of change in wet to dry environment and change in temperature from room temperature to 80°C on nanomechanical properties of fresh water shrimp exoskeleton. Scanning electron microscopy based measurements suggest that the shrimp exoskeleton has the Bouligand structure in its layers, a key characteristic of the crustaceans. The thickness of the layers and packing density is found to be different than that of lobsters and crabs reported earlier in the literature. As expected, the wet samples are found to be softer than dry samples. The reduced modulus values of dry samples are found to be around 26 GPa as compared to be ~5 GPa in the case of wet samples. Similarly the hardness values are found to be ~1 GPa in the case of dry samples as compared to the corresponding values being ~0.2 GPa in the case of wet samples. In order to simulate the influence of underwater pressure on the exoskeleton strength, constant load creep experiments as a function of wet and dry environment are performed. Effect of increased temperature on the properties is also analyzed in terms of creep mechanisms. Both reduced modulus and hardness values show a decrease with increase in the temperature. The reduced modulus values are found to be around 28 GPa at 30°C that reduces to ~24 GPa at 80°C. The hardness values also decrease from 1.6 GPa at 30°C to ~1.2 GPa at 80°C. The switch in deformation mechanism as function of environment is explained based on the role played by water molecules in assisting interface slip and increased ductility of matrix material in the fiber/matrix and deformation.