

MATERIAL PROPERTIES OF THE FOREWING OF CICADAS

Song Fan (宋凡) Bai Yilong (白以龙)

(State Key Laboratory of Nonlinear Mechanics (LNM), Institute of Mechanics, Chinese Academy of Sciences, Beijing 100080, China)

Detailed investigations on the structural and mechanical properties of the forewing of cicada were carried out. The measurement of the structures of the wings showed that the thickness of the membrane of each cell and the diameter of each vein were nonuniform in both the longitudinal and transverse directions, and were about 8~16 μm and 51~256 μm , respectively. However, the aspect ratio of the wings and the bodies were quite uniform and were approximately equal to 0.33 and 0.46, respectively. Based on the measured thickness, weight and area of the membranes of the cells, the average density and the average area density of the wing were approximately 2.3 g/cm³ and 2.8 $\times 10^{-3}$ g/cm², respectively. In addition, the diameters of the veins of the wings, including the diameters of the holes in the vein of the leading edge, were examined. The mechanical properties of the wing were investigated separately by nanoindentation and tensile testing. The results indicated that the average Young's modulus, hardness and yield stress of the membranes of the wings were about 3.7GPa, 0.2GPa and 29MPa, respectively, and the average Young's modulus and strength of the veins along the direction of the venation of wings were approximately 1.9GPa and 52MPa, respectively. Finally, the relevant results were briefly analyzed and discussed, which provide a guideline to the biomimetic design of the aerofoil materials of micro air vehicles.