Non-Isotropic Fiber Reinforced Elastic Membranes for Micro Air Vehicle Wings

By Josh Wilcox
Candidate for Master of Science in Mechanical Engineering

Abstract

Micro air vehicles (MAV’s) and small unmanned aerial vehicles (SUAV) are remotely piloted or autonomous aircraft with a take-off mass range between 50 g and few kilograms. These vehicles, as well as natural fliers such as bats and insects, utilize a variety of elastic wing structures including thin membranes. Bat wings have non-isotropic membranes supported by battens, while current MAVs and SUAVs are fabricated with pliant isotropic materials such as silicone and latex.

During the development process, non-isotropic properties of the membrane are achieved through specific material selection, fiber ratio, and fiber pretension in a spandex-fiber reinforced silicone-matrix. Wet layup fiber composite and casting techniques, applied to the selected materials, resulted in a non-isotropic elastic membrane with the desired mechanical characteristics. Static pressure differential and wind tunnel tests successfully demonstrated the desired correlation between membrane composition and elastic response to loading conditions. By developing an artificial wing-membrane design characterized by anisotropic properties, researchers will provide a method of advancing synthetic aerial vehicles toward the flight capabilities of natural fliers.