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Title

Fabrication and Testing of Elastomeric Composite skin for 1D Morphing Wing Application

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Abstract

This paper presents the fabrication and testing of an elastomeric composite skin that is suitable for use in a morphing wing application. The use of morphing wing technology is an emerging trend in the field of aerospace engineering and has the potential to improve the performance of aircraft significantly [1]. The ability of a wing surface to change its geometry during flight has interested researchers and designers over the years as this reduces the design compromises required. The morphing wing technology changes the shape of the wing based on data gathered by sensors such as pressure, temperature, and flow. NASA has used morphing wing technology in their Flexible Aircraft Research Rig (FARIR), which is essentially a bionic demonstration of morphing wing technology. The FARIR aircraft was designed with the ability to change wing shape to optimize performance based on various flight conditions. The elastomeric composite skin developed in this paper is made of an elastomeric polymer matrix (Ecoflex) reinforced with carbon fibers. The fabrication process involves layering and curing the Ecoflex with unidirectional carbon fiber, resulting in a lightweight and flexible composite skin that can bear the aerodynamic load and deform easily with less actuation force requirement. To evaluate the even distribution of carbon fibers within the matrix, a nondestructive imaging technique called X-ray tomography was used. The microstructural 3D images obtained from the technique confirm the even distribution of fibers in the matrix, which contributes to the skin's mechanical performance. The mechanical properties of the composite skin, including tensile strength, elongation at break, and Young's modulus, were measured through testing. The results demonstrate that the composite skin has high mechanical performance and large deformation capabilities with a zero poisons ratio. This makes the composite skin suitable for use in a 1D morphing wing application, where it is capable of span morphing with nearly zero poisons ratio. The development of this elastomeric composite skin for morphing wing applications is a significant advancement in the field of aerodynamics. The use of such skins can lead to more efficient aircraft designs with less compromise on performance. By changing the wing shape during flight, the aircraft can achieve better lift-to-drag ratios, leading to increased fuel efficiency and improved flight performance. Furthermore, the nondestructive imaging technique used in this paper to evaluate the distribution of carbon fiber within the elastomeric skin can be applied to other composite materials in the future. This technique can contribute to the development of stronger and lighter materials for various engineering applications. In conclusion, the development and testing of the elastomeric composite skin for morphing wing applications is a significant achievement in the field of aerodynamics. The use of such skins can lead to more efficient and advanced aircraft designs with less compromise on performance. The morphing wing technology has great potential in the field of aerospace engineering, and this study provides a valuable contribution to the development of this technology.

References

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