Abstract

Electroactive polymers (EAP) are a class of smart materials which exhibit a shape change under an applied voltage. They have been shown to work in subzero temperatures and have relatively higher deformation capabilities. These polymers would serve as a mechanical method to remove accumulated ice from a surface. They are similar to deicing boots currently used, which expand pneumatically and break off the ice. These materials can be installed on surfaces which go under icing situations, and then be actuated when needed to break the ice off. Ionic is specifically a problem on wing structures used in airplanes, wind turbines, helicopters, etc. Ice formation on airfoils changes the angle of attack of the wing and causes stalling of the wing, thus rendering it inefficient. Unlike traditional mechanical systems which can only cover parts of the surface, EAPs can be used to span the entire surface and provide protection against ice. They also use less energy, are lightweight, have a faster response rate and are not fragile like pneumatic systems. The experiment consisted of building an ionic polymer metal composite which is an Ionic EAP. This was then be attached to a metal surface in the shape of a wing. This whole setup was then subjected to freezing conditions which would result in ice formation on it. The deicing capabilities would then be tested by actuating the EAP and recording the observed effects. The experiment would then be repeated multiple times with different ice thicknesses and varied time periods for which the structure was subjected to icing environment.

Background

Ionic EAPs are polymers in which actuation is caused by displacement of ionic groups and water molecules inside the polymer due to an applied external field. They require low voltage for actuation but due to the ionic flow, they need higher electrical power. They have a practical advantage over other forms of EAPs. Ionic polymer-electrode composites are types of Ionic EAPs, which consist of a thin ionicomeric membrane with electrodes, usually metals, plated on its surface. They show very high deformations on an application of low voltage and are very active actuators.

Methods

The Electroactive polymer (EAP) is used in the form of a sleeve that wraps around the wings of the aircraft. When electric current is passed through it, the sleeve morphs and the subsequent deformation breaks up the ice build up. To better explain the working, we designed an experiment that can be used to show the workings of the EAP sleeve. The entire setup is housed inside a freezer that mimics the atmospheric conditions at approximately 30,000 feet. The airfoil on which the EAP sleeve will be attached is housed inside, on a base. A fan is used to mimic airflow over the airfoil, while an atomizer is used to spray mist. We plan to use this mist to mimic the supercooled water droplets that form in the atmosphere.

Discussion

The cations in the ionic polymer-electrode composite are randomly oriented in the absence of an electric field. Once a field is applied the cations gather to the side of the polymer in contact with the anode causing the polymer to bend.

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