***Development of Self-Actuating In-Flight Deicing Structures***

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***Abstract***

A proof of the concept of utilizing smart structures for in-flight deicing with minimal power requirements is proposed. Lightweight piezoelectric actuators with positive feedback control are utilized to excite the underlying structures to their natural frequencies. This induces shear stresses on the surface of the structures with a low power requirement. The shear stresses generated are sufficient to break the adhesive bond between the ice layer and the wing surface, which is weak in shear. A laminated composite cantilever plate and a prototype leading-edge wing structure are investigated. Analytical studies are performed to determine the critical modes in which high amount of shear stresses can be generated on the surface of the structures and to evaluate the debonding requirement of the ice patches from the surface. Experimental verification of the proposed inexpensive deicing method is carried out by forming ice patches on both the composite plate and the curved leading-edge wing structures, then actuating the structures to the targeted natural frequencies. Testing is conducted at five different cold temperatures ranging from 258.15 to 269.26 K. The implementation proves that the proposed smart structural deicing method is effective and energy- and weight-efficient, which is most desirable for aircraft applications. The method is superior in that there is a reduction in power consumption by two orders of magnitude for aircraft deicing setups over the existing ones.