# Internship topic

# Smart structures

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## Project 1: Acoustic De-icing

The aim of the project is to evaluate the design and feasibility of de-icing solutions for aeronautical structures based on piezoelectric elements. The underlying principle of these de-icing methodologies is to generate vibrations by the piezoelectric elements, which will generate stress fields sufficient to loosen the ice from the parts of interest. Compared with other technological solutions (thermal, electrothermal, pneumatic or mechanical), these solutions have the advantage of being less energy-intensive, less cumbersome and less polluting, making them industrially very attractive.

The work consists of carrying out tests on a test bench and using the numerical simulator (Abaqus/Matlab) developed in the lab to predict defrosting and also to characterize the properties of the frost. The test rig consists of a rectangular aluminum plate placed in a climatic chamber, on which a layer of frost is generated on its upper surface. Two **piezoelectric** elements are glued to the underside. The aim is to impact this plate with an instrumented impact hammer (*i.e.* fitted with an accelerometer and a force cell) driven by a stepper motor, so as to ensure reproducibility of the tests and avoid bouncing as much as possible. Tests are also filmed. Thus, using the information obtained at the point of impact (force, acceleration), the data measured by the piezoelectric elements (voltages) and the images recorded by the camera, it will potentially be possible to estimate interesting icing properties.

**Key words:** Piezoelectricity, acoustics, numerical simulation, experiment, modal analysis, optimization

## Project 2: Smart Foil

The project is dedicated to the static and vibration control of hydrofoil-type airfoils. Under certain flow regimes, these surfaces are subject to vibratory and cavitation phenomena that lead to a reduction in hydrodynamic performance and an increase in noise. Current solutions are often based on geometric modification of a profile considered to be rigid. Some of these modifications are detrimental to performance and are not always robust to changing flow conditions. Rather than modifying the geometry of the structures under consideration, the solutions envisaged in this project are based on integrating "active" materials such as shape memory alloys, piezoelectric materials and electroactive polymers into the bearing surfaces.

The objective is to demonstrate that geometric modifications (**Shape Control**) can be carried out on a foil in order to adapt it to different flow conditions. The methods implemented to modify the geometry of the bearing plane by using **piezoelectric** actuators coupled with an **electrical actuation**. The aim is to develop a <u>first prototype</u> based on existing numerical work and experimental studies.

**Key words:** Experiment, vibration control, modal analysis, Matlab/Simulink la stratégie retenue intègrera des **matériaux piézoélectriques** dont la forme, la position et le nombre restent à déterminer.