Active deformation of dielectric elastomer for detection of biofouling

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Biofouling accumulation on synthetic underwater surfaces presents serious economic problem for the marine industry.

When a substrate-bonded dielectric elastomer (DE) is subjected to high voltage, deformations in form of creases can be formed at the surface of the DE. This deformation, has been already demonstrated for the prevention and detachment of biofouling from the surface of DEs. In this work we add sensing capabilities to the anti-biofouling effect of active DE surfaces. A device consisting of a metallic plate, a Kapton sheet, and a thin silicone membrane is immersed in saltwater, which acts as one electrode, with the metal plate being the second electrode. The surface deformation of the silicone as a function of applied voltage is monitored under microscope.

Because the membrane is made from incompressible elastomer and bonded to a rigid substrate, voltages below the creasing threshold create no deformation in the membrane, and therefore no change in capacitance. Above the voltage threshold, crease instabilities appear at the surface of the silicone, thus increasing the capacitance of the device. The capacitance of the sensor is measured as a function of applied voltage, and the voltage at which the capacitance increases identifies the threshold voltage at which creases occur. When stiff biofouling material attach to the surface of the silicone, the threshold voltage necessary to develop the creases increases. Measuring the capacitance versus voltage enables to identify the creasing threshold, and therefore monitor the evolution of biofouling. Such a device provides a new tool for condition monitoring of submerged marine surfaces.