Smart blades with actively controlled compliant skin

Smart blades with actively compliant skin

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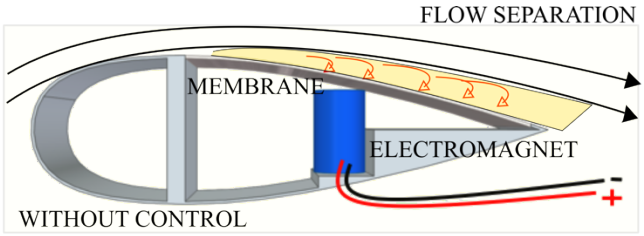
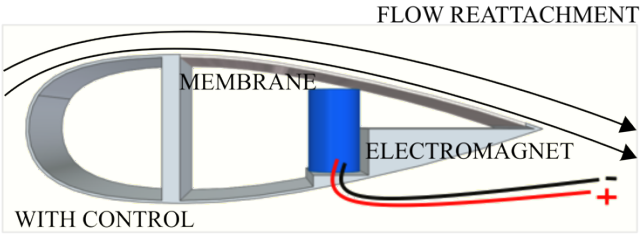
As new materials are developed to make wind turbine blades lighter and recycle friendly, new opportunities emerge to design smart materials that tackle fundamental fluid dynamic problems, such as flow separation. To this aim, we introduce a technology tailored to prevent flow separation through an actively compliant skin. The skin of the blade oscillates to enhance mixing in the boundary layer of the blade and prevent flow separation. We show this with a 3D printed section of a blade manufactured with a magnetoelastic membrane. The membrane covers a small recess on the suction side of the blade and vibrates energising the boundary layer, thus preventing flow separation. The membrane is actuated via electromagnets positioned inside of the blade. Hence, the assembly avoids moving joints and ensure that the electronics remain isolated from the environment. The control of a membrane was tested on a model-scale blade section in air and water using off-the-shelf components and the deformation of the membrane was measured at different speeds with an optosensor. Force measurements were carried out in a water tunnel showing that high frequency actuation increases the lift force on the blade.

a)



b)



Cross-section of blade a) without membrane control and with flow separation and b) with membrane control and with flow reattachment