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The Influence of Surface Roughness on the Flow Fields Generated by an Oscillating Cantilever

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Abstract : With the current trend of miniaturisation of electronic devices, piezoelectric fans have attracted increasing interest as an alternative means of forced convection over traditional rotary solutions. Whilst there exists an abundance of research on various piezo-actuated flapping fans in the literature, the geometries of these fans all consist of a smooth rectangular cross section with thicknesses typically of the order of 100 um. The focus of these studies is primarily on variables such as frequency, amplitude, and in some cases resonance mode. As a result, the induced flow dynamics are a direct consequence of the pressure differential at the fan tip as well as the pressure-driven 'over the top' vortices generated at the upper and lower edges of the fan. Rough surfaces such as golf ball dimples or vortex generators on an aircraft wing have proven to be beneficial by tripping the boundary layer and energising the adjacent air flow. This paper aims to examine the influence of surface roughness on the airflow generation of a flapping fan and determine whether the induced wake can be manipulated or enhanced by energising the airflow around the fan tip. Particle Image Velocimetry (PIV) is carried out on mechanically oscillated rigid fans with various surfaces consisting of pillars, perforations and cell-like grids derived from the wing topology of natural fliers. The results of this paper may be used to inform the design of piezoelectric fans and possibly aid in understanding the complex aerodynamics inherent in flapping wing flight.

Keywords : aerodynamics, oscillating cantilevers, PIV, vortices
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