Roughness Effects on the Formation of a Leading Edge Vortex

CASSIDY ELLIOTT, AMY LANG, The University of Alabama, REDHA WAHIDI, The University of Texas of the Permian Basin, JACOB WILROY, The University of Alabama — Microscopic scales cover the wings of Monarch butterflies, creating a patterned surface that acts as a natural energy capture mechanism. This patterning is thought to delay the growth of the leading edge vortex (LEV) produced by the flapping motion of a wing. Increased skin friction caused by the scales leads to a weaker LEV being shed into the butterfly’s wake, lessening drag and increasing flight efficiency. To test how this roughness effects LEV formation, a plate of random roughness was designed in SolidWorks and printed on the Objet 30 Pro 3D printer. A 2x3x5 cubic foot tow tank was used to test the rough plate at Reynolds' numbers of 1500, 3000, and 6000 (velocities of 8, 16, and 32 mm/s) at an angle of attack of 45 degrees. Images were captured of the LEV generated when the plate was towed upwards through the particle-seeded flow. These images were used to determine the XY velocity of the particles using a technique called Digital Particle Image Velocimetry (DPIV). Codes written in MATLAB were used to track and measure the strength of the LEV. Circulation values for the randomly-rough plate were then compared to the same values generated in a previous experiment that used a smooth plate and a grooved plate to determine the effect of the patterning on vortex development.

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