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Roughness Effects on the Formation of a Leading Edge Vortex[1]
CASSIDY ELLIOTT, AMY LANG, REDHA WAHIDI, JACOB WILROY, The University of Alabama — Microscopic scales cover the wings of Monarch butterflies, creating a patterned surface. This patterning is an important natural flow control mechanism that is thought to delay the growth of the leading edge vortex (LEV) produced by the flapping motion of a wing. The 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 this theory, 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 Reynold's numbers of 1500, 3000, and 6000 (velocities of 8, 16, and 32 mm/s) at an angle of attack of 45 degrees. Particle Image Velocimetry (PIV) captured images of the LEV generated by the plate when towed upwards through the particle-seeded flow. Codes written in MatLab were used to automatically track and determine 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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