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Unsteady aerodynamics of membrane wings with adaptive compliance JILLIAN KISER[1], KENNETH BREUER, Brown University — Membrane wings are known to provide superior aerodynamic performance at low Reynolds numbers ($Re = 10^4 - 10^5$), primarily due to passive shape adaptation to flow conditions. In addition to this passive deformation, active control of the fluid-structure interaction and resultant aerodynamic properties can be achieved through the use of dielectric elastomer actuators as the wing membrane material. When actuated, membrane pretension is decreased and wing camber increases. Additionally, actuation at resonance frequencies allows additional control over wing camber. We present results using synchronized (i) time-resolved particle image velocimetry (PIV) to resolve the flow field, (ii) 3D direct linear transformation (DLT) to recover membrane shape, (iii) lift/drag/torque measurements and (iv) near-wake hot wire anemometry measurements to characterize the fluid-structure interactions. Particular attention is paid to cases in which the vortex shedding frequency, the membrane resonance, and the actuation frequency coincide. In quantitatively examining both flow field and membrane shape at a range of actuation frequencies and vortex shedding frequencies, this work seeks to find actuation parameters that allow for active control of boundary layer separation over a range of flow conditions.

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