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Force and Power Measurements of a Functionally-Graded Chordwise-Flexible Flapping Wing[1] DURLAV MUDBHARI, MALCOLM ERDOGAN, KEITH MOORED, Lehigh University — Flyers and swimmers flap their wings and fins to propel themselves efficiently over long distances. A key element to achieve their high performance is the flexibility of their appendages. While numerous studies have shown that homogeneously flexible wings can enhance force production and efficiency, animals actually have wings with varying flexural rigidity along their chord and span. The goal of this study is to understand and characterize the force production and energetics of functionally-graded, chordwise flexible wings. A flapping wing composed of a rigid and a flexible region, that define a chordwise gradient in flexural rigidity, is used to model functionally-graded materials. By varying the ratio of the lengths of the rigid to flexible regions, the flexural rigidity of the flexible region, and the flapping frequency, the thrust production of a functionally-graded wing is directly measured in a wind tunnel. A novel vacuum chamber apparatus is used in conjunction with the wind tunnel measurements to reliably measure the aerodynamic power input and the propulsive efficiency. Limited flow visualization is performed with particle image velocimetry in order to connect the force production and energetics of the partially-flexible wing with its generated flow structures.

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