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Investigating the Force Production of Functionally-Graded Flexible Wings in Flapping Wing Flight[1] DURLAV MUDBHARI, MALCOLM ERDOGAN, KAI HE, DANIEL BATEMAN, RORY LIPKIS, KEITH MOORED, Lehigh University — Birds, insects and bats oscillate their wings to propel themselves over long distances and to maneuver with unprecedented agility. A key element to achieve their impressive aerodynamic performance is the flexibility of their wings. Numerous studies have shown that homogeneously flexible wings can enhance force production, propulsive efficiency and lift efficiency. Yet, animal wings are not homogenously flexible, but instead have varying material properties. The aim of this study is to characterize the force production and energetics of functionally-graded flexible wings. A partially-flexible wing composed of a rigid section and a flexible section is used as a first-order model of functionally-graded materials. The flexion occurs in the spanwise direction and it is affected by the spanwise flexion ratio, that is, the ratio of the length of the rigid section compared to the total span length. By varying the flexion ratio as well as the material properties of the flexible section, the study aims to examine the force production and energetics of flapping flight with functionally-graded flexible wings.

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