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Metachronal Motion of Artificial Cilia[1] SRINIVAS HANASOGE, PETER HESKETH, ALEXANDER ALEXEEV, Georgia Tech, MATTHEW S. BALLARD, Saint Martin's University; Georgia Tech — Most microorganisms use asymmetrically oscillating hair like cilia on their surface to achieve fluid transport. These cilia are often seen to beat in a metachronal fashion with a constant phase difference with the neighbors which generates a travelling wave. Although the origin of metachronal waves in such cilia is not well understood, mimicking such behavior in synthetic systems could prove useful in achieving similar advantages. In this work, we demonstrate metachronal waves in synthetic magnetic ciliary systems. The soft magnetic cilia are forced by a uniform rotating magnetic field. The cilia bend as the field rotates and tend to align along the direction of field to minimize the potential energy. Longer cilia bend to a larger degree, while the shorter cilia show less bending. This difference in the bending of cilia based on their length leads to a phase difference in their oscillation cycle. We exploit this phase differences to metachronally oscillate the synthetic cilia. We fabricate an array consisting of cilia with increasing lengths, in which the cilia beat with a constant phase difference with the neighboring cilia, producing a travelling wave. Such behavior could potentially be useful in enhanced fluid and particle transport as seen in natural systems.

[1]USDA

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