Micro-Cilia for Pumping and Generation of Metachronal Waves (#7778, 7586)

An array of magnetically actuated micro-cilia based upon fabrication of thin film of magnetic materials

Georgia Tech inventors have developed an array of magnetically actuated micro-cilia based upon fabrication of thin film magnetic materials which can be actuated by an electrostatic actuator. The cilia moves with an asymmetric motion to produce fluid circulation and pumping in a microchannel and are dependent upon the actuation frequency, number of rows of cilia, and spacing between the cilia in the array. The stiffness of the cilia is defined by the dimensions and mechanical properties of the thin metallic film they are made from. To tune the mechanical properties and influence the asymmetry of the beating motion of the cilia, an electrostatic actuator is integrated with the magnetic cilia. It provides an additional force dependent upon the gap between the cilia and the substrate, providing the ability to switch between different modes of the asymmetric motion and fluid direction of circulation in a microchannel. The rotation rate of the magnet is controlled to adjust the beating frequency and amount of pumping/mixing produced.

Benefits/Advantages

- **Ease of use** - Device pumping rate can be controlled externally with rotation of a magnet
- **Adjustable** - Ability to tune mechanical properties to influence the asymmetry of cilia’s beating motion
- **Fine-tuned** - An individual cilia in an array can change its own properties

Potential Commercial Applications

- Provide pumping or fluid sample mixing in a channel (e.g. catheter)
- Fabrication and actuation for microfluidic devices

Background/Context for This Invention

Researchers have recently shown various fabrication and actuation methods for artificial cilia and have studied its applicability in Lab-On-Chip devices for mixing, pumping and other microscale fluid handling processes. Among the different techniques demonstrated, magnetic cilia is particularly popular due to its ease of actuation, with any time-varying magnetic field that can be used to oscillate such cilia. Various fabrication techniques to realize artificial magnetic cilia, including roll up methods, magnetic particles in polymer, and beads self-assembly, have been demonstrated. Unfortunately, these methods rely on complicated fabricated steps and are often unreliable For instance, the mechanical properties of polymeric cilia are difficult to predict as the composition of the polymer and curing temperatures affect its properties.
Metachronal Magnets, Nature Research, June 4, 2018

For more information about this technology, please visit: