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Mechanical Reliability of Implantable Polyimide-Based Magnetic Microactuators for Biofouling Removal

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ABSTRACT

Hydrocephalus is a neurological disorder that typically requires a long-term implantation of a shunt system to manage its symptoms. These shunt systems are notorious for their extremely high failure rate. More than 40% of all implanted shunt systems fail within the first year of implantation. On average, 85% of all hydrocephalus patients with shunt systems undergo at least two shunt-revision surgeries within 10 years of implantation. A large portion of this high failure rate can be attributed to biofouling-related obstructions and infections. Previously, we developed flexible polyimide-based magnetic microactuators to remove obstructions formed on hydrocephalus shunts. To test the long-term reliability of these magnetic microactuators, here we evaluate the impact of actuation cycle on mechanical stability of these microdevices. Over 50 minutes, 8 devices were actuated at 100 Hz at 37 °C continuously in phosphate buffered solution. By measuring the primary resonant frequency of each device, we were able to quantify changes in the structural integrity of each actuator. On average, the devices showed a drop of 2.15% in resonant frequencies. Although additional evaluations are necessary to ascertain appropriate actuation duty cycles, preliminary results suggest that our polyimide-based devices have good mechanical reliability, which bodes well for our ultimate goal of improving quality of life and care for hydrocephalus using our MEMS-enabled self-clearing catheters.

KEYWORDS

Magnetic microactuators, polyimide, hydrocephalus, fatigue, MEMS, biofouling