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微纳技术与精密机械

柔性MEMS减阻蒙皮设计及其制作工艺

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摘要： 提出了一种电解水式驻留微气泡减阻的柔性微机电系统(MEMS)蒙皮技术,研究了蒙皮结构设计以及加工工艺。设计了一种包含柔性基底层、金属电极图案层和微凹坑阵列层的三层式蒙皮结构,提出了两种基于MEMS工艺的制作方法。分别采用聚二甲基硅氧烷(PDMS)和SU-8胶材料制作了微凹坑阵列层,并对其关键工序进行了实验研究。以SU-8胶为微凹坑阵列材料制作了柔性MEMS蒙皮样件。所制样件中,圆柱形驻气凹坑的直径为40 μm、深度为50 μm、密度为6.25×10^4/cm^2、样件总厚度为90 μm,可弯曲并贴附于截面直径为28 mm的圆柱体表面而不损坏。结果显示了MEMS减阻蒙皮工艺的可行性,证明将电解水式驻留微气泡的柔性减阻蒙皮设计与MEMS工艺有机结合,是一种航行体表面减阻的有效技术途径。

关键词： 减阻蒙皮 柔性MEMS 微气泡 微凹坑 SU-8胶 聚二甲基硅氧烷(PDMS)

Design and fabrication of flexible MEMS anti-drag skin

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Abstract: A novel flexible Microelectromechanical System(MEMS) anti-drag skin was proposed based on the drag reduction with lingering-micro-bubble generated by electrolysis, and the fabrication of flexible MEMS anti-drag skin was designed. The MEMS skin composed of a flexible substrate layer, a metal electrode layer and a micro-well-array layer was designed,and two process routes based on MEMS were developed for the skin fabrication.Then,the polydimethylsiloxane(PDMS) and SU-8 were used to fabricate the micro-well-array layer, respectively. Several key steps in these processes were studied and a specimen was fabricated using SU-8. The specimen has a thickness of 90 μm and contains 6.25×10^4 cylindrical wells with a depth of 50 μm and a diameter of 40 μm per square centimeter. It can be bent and attached on a Φ28 mm cylinder without damage. Results demonstrate that the MEMS is feasible to realize the anti-drag skin and the flexible MEMS anti-drag skin offers a novel way to reduce the skin friction of vehicles in water.

Keywords: anti-drag skin flexible Microelectromechanical Systems(MEMS) micro bubble micro well SU-8 polydimethylsiloxane(PDMS)

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