传感技术学报
中国微米纳米技术学会
全国高校传感技术研究会 主办

采用硅和PDMS的堆栈式微型直接甲醇燃料的设计和制作

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基金项目：基于MEMS的硅基微型燃料电池关键工艺与材料的基础研究

摘　要：

在堆栈式微型直接甲醇燃料电池（Micro-direct methanol fuel cell，简称μ-DMFC）中，为了避免硅基流场板因为封装压力过大而破裂，采用了硅和PDMS（Polydimethylsiloxane，聚二甲基硅氧烷）材料分别制作阳极和阴极流场板。首先，采用MEMS（Micro-Electro-Mechanical Systems，微机电系统）技术制作硅基阳极流场板。其次，通过铜箔与阴极流场板一体成型、有机清洗和PDMS 表面活化等改进措施显著提升了PDMS阴极流场板金属化的能力。最后，比较和分析阳极流场板上三种不同结构的流道形式的堆栈式μ-DMFC 的输出性能。实验结果表明，活化后的PDMS 阴极流场板与Cr/Au 的粘附性能和粘接强度显著提高，同时阳极流场板的流道一半开设为凸台，一半开设为通孔时，其堆栈式μ-DMFC 的输出性能最优。最大输出电流密度为81.25mA/cm2，最大输出功率为7.73mW/cm2。采用硅和PDMS 材料分别制作流场板，不仅简化了堆栈式μ-DMFC 的结构，而且能够缓冲锁紧力，有效保护硅基阳极流场板。同时优化阳极流场板上的流道结构，能够有效提升堆栈式μ-DMFC 的输出性能。

关键词：堆栈式微型直接甲醇燃料电池　微机电系统　PDMS流场板　金属化

The design and fabrication of stack micro-direct methanol fuel cell using silicon and PDMS

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Abstract:

In order to avoid cracks of the silicon flow field plate caused by high package pressure, silicon and PDMS（Polydimethylsiloxane）are used as anodic and cathode flow field plate respectively in the stack μ-DMFC (Micro-direct methanol fuel cell). The anodic flow field plate based on silicon is fabricated with MEMS (Micro-Electro-Mechanical Systems) technology, and cathode flow field plate is fabricated using PDMS and its metallic performance is evidently improved by means of integral shaping of copper foil and cathode flow field plate, organic cleaning and activation on PDMS surface. The output of stack μ-DMFC is tested and analyzed, in which 3 different flow channel structures on the anodic plate are introduced. Tested results verify that adhesive capacity and strengthen between post-activated PDMS and Cr/Au is greatly improved, and when micro blocks and through holes are introduced alternately in the flow channel of anodic flow field plate the stack μ-DMFC can obtain the maximum output, with voltage of 0.5V, current density of 81.25mA/cm2 and output power density of 7.73mW/cm2. This study shows that using silicon and PDMS as flow field plate respectively not only simplifies the structure of stack μ-DMFC but also cushions clamping force and effectively protects anodic flow field plate, and furthermore to increase the output of stack μ-DMFC by optimizing structure of flow channels on the anodic flow field plate.

Keywords: Stack μ-DMFC, MEMS, Flow field plate of PDMS, Metallic characteristic

投稿时间：**2012-09-12**

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