# Fabrication and characterization of a suspended micro-reformer unit fully integrated in silicon for DME steam reforming

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This work reports the design, manufacturing and experimental results of a micro-reformer for hydrogen-rich gas generation from dimethyl ether (DME) for portable-solid oxide fuel cell (SOFC) feeding. The reformer has been designed as a silicon micro monolithic substrate compatible with the mainstream microelectronics fabrication technologies (photolithography, wet etching, chemical vapor deposition and reactive ion etching) ensuring a cost-effective high reproducibility and reliability[1].
Design and geometry of the system have been optimized for minimizing heat losses in order to satisfy the temperature requirements of the reforming process. The current design has dimensions of 10x10 $mm^2$ in area, 500 µm (see Fig. 1) in thickness and an effective reactive area of about 5.5 $cm^2$, which consists of an array of more than $7x10^3$ vertical micro channels perfectly aligned (50 µm diameter, see Fig. 2) and a 5 W integrated serpentine heater consisting of three stacked metallic layers (TiW, W and Au) for perfect adhesion and passivation (see Fig. 3).
These micro channels have been coated by atomic layer deposition (ALD) with amorphous $Al_2O_3$, a catalytic support on which the Pd catalyst have been deposited (see Fig. 4) by impregnation[2] and a study on the post-deposition conditions has been performed. The specific hydrogen production rates, DME conversion and selectivity profiles of the herein reported catalytic system have been successfully tested by means of a customized ceramic 3D-printed holder (see Fig. 5) at 450-650°C temperature range.
This functional converter is the basis for a complete gas processing unit as a subsystem of an entire micro-SOFC system.

**References**

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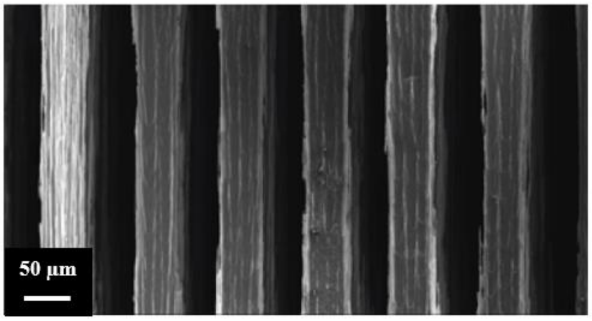


Figure 1. Cross-section SEM image of the 500 µm-long micro-channels

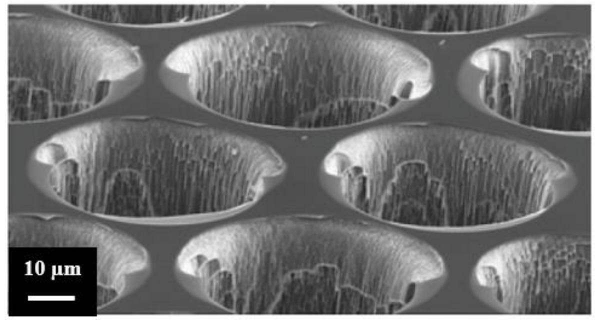


Figure 1. Top view SEM image of the vertical micro-channels after deep RIE

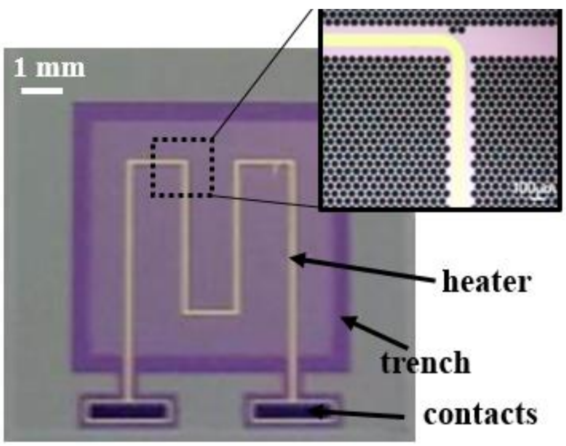


Figure 3. Picture of the micro-reformer and OM (20x) view of the heater in the inset

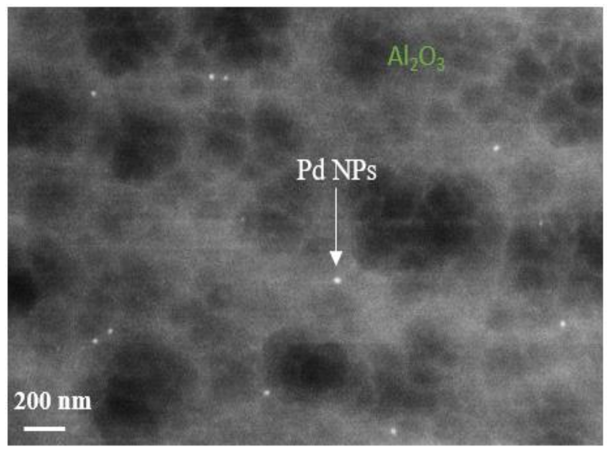


Figure 4. SEM image of Pd nanoparticles grafted onto $Al_2O_3$ layer inside the micro-channels

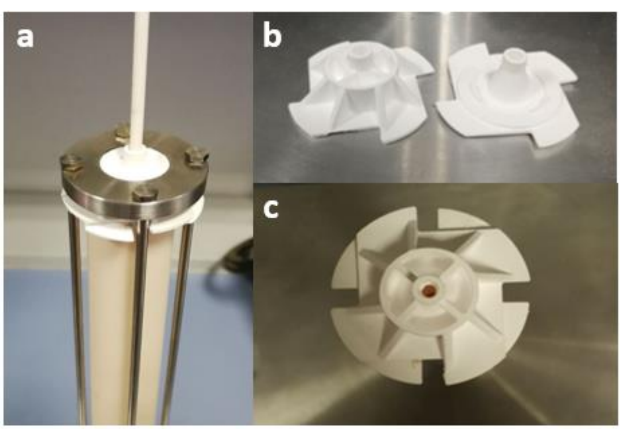


Figure 5. (a) high-temperature setup for activity measurements, (b) spare parts of the holder and (c) top view of the holder.