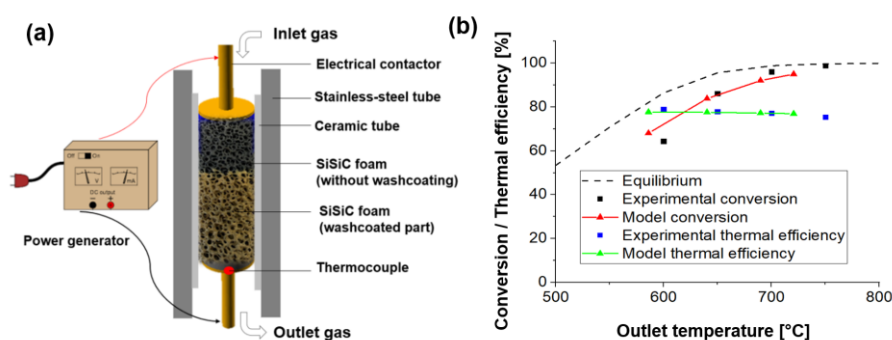


## Electrified Methane Steam Reforming via Resistive Heating of SiSiC Foams Washcoated with a Rh/Al<sub>2</sub>O<sub>3</sub> Catalyst

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### Abstract

Electrified methane steam reforming (eMSR), as a promising concept for low-carbon H<sub>2</sub> production, offers great potential to exploit excess renewable energy and mitigate CO<sub>2</sub> emissions.<sup>1</sup> In this context, we have systematically investigated a Rh/Al<sub>2</sub>O<sub>3</sub> washcoated SiSiC foam-based eMSR system,<sup>2</sup> where the SiSiC foam serves as the coated catalyst support as well as the Joule heating element (Fig. 1(a)). We tested foams with different catalyst loadings, at different space velocities and different operative pressures. During the test, the voltage of the power generator was varied to reach a target outlet temperature, measured at the end of the catalytic bed. The results demonstrated methane conversions close to equilibrium at space velocities as high as 150.000 Ncc/h/g<sub>cat</sub>. In these conditions the lab-scale system was operated with a power density of 8 MW/m<sup>3</sup>, i.e., higher than in industrial reformers. The heat losses are a sole function of the internal reactor temperature; therefore, the thermal efficiency of the system increases on incrementing the space velocity and the catalyst inventory, reaching unprecedented values of 80%. Fig. 1 (b) shows that our modelling results can predict both methane conversion and thermal efficiency with reasonable accuracy. Accordingly, the model was used to design a preliminary scaled-up eMSR unit. The system is designed so that the total ΔV across the system is equal to 380 V, the catalyst inventory is equal to 100 g/l. The foam diameter was set equal to 12 cm, considering the current manufacturing limits of SiC foams. This unit is able to produce 200 Nm<sup>3</sup>/h of hydrogen.



**Figure 1:** a) Experimental setup, b) experimental versus modelling results for a SiSiC foam with  $d = 3.2$  cm, coated with 5.5 g of Rh/Al<sub>2</sub>O<sub>3</sub> catalyst. GHSV = 150000 Ncc/h/g<sub>cat</sub>.

### Acknowledgements

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (GA No. 694910 -'INTENT'), and the project "PLUG-IN" funded by the MIUR Progetti di Ricerca di Rilevante Interesse Nazionale (PRIN) Bando 2020.

### References

1. S.T. Wismann *et al.*, *Science*, 2019, **364**, 756-759.
2. L. Zheng *et al.*, *AIChE J.*, 2022, doi.org/10.1002/aic.17620.