

Technical University of Denmark



## Advanced manufacturing of porous ceramic structures for use in energy applications (invited)

**Kaiser, Andreas; Bjørnetun Haugen, Astri; Zhang, Wenjing (Angela); Ovtar, Simona; Kiebach, Wolff-Ragnar; Hendriksen, Peter Vang**

*Published in:*

Book of abstracts - 15th Conference & Exhibition of the European Ceramic Society (ECerS2017)

*Publication date:*

2017

*Document Version*

Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*

Kaiser, A., Bjørnetun Haugen, A., Zhang, W. . A., Ovtar, S., Kiebach, W-R., & Hendriksen, P. V. (2017). Advanced manufacturing of porous ceramic structures for use in energy applications (invited). In Book of abstracts - 15th Conference & Exhibition of the European Ceramic Society (ECerS2017) (pp. 11). [832]

## DTU Library

Technical Information Center of Denmark

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

832

## Advanced manufacturing of porous ceramic structures for use in energy applications

*A. Kaiser\**, A.B. Haugen, W. Zhang, S. Ovtar, R. Kiebach, P.V. Hendriksen

DTU Energy, Department of Energy Conversion & Technical University of Denmark (DTU), Frederiksborgvej 399, 4000 Roskilde, Denmark; \*e-mail: akai@dtu.dk

**Keywords:** porous ceramics, multilayer, membrane, gas separation

Tailored porous ceramic materials and structures are utilized in energy devices at DTU Energy, including electrochemical converters, membranes, adsorbents for gas separation and storage and catalyst supports. These materials can contain pore sizes from the nanometers to several millimeter, and can have oriented to random porosity or hierarchical porosity based on various pore architectures. Ceramic structures with tailored porosity can be processed by a variety of traditional or advanced shaping methods (phase inversion tape casting, templating, freeze casting, electrospinning, etc.).

Often, some additional challenges need to be addressed if porous support or catalysts layers with tailored porosity need to be integrated into asymmetric multilayer gas separation devices to achieve high performance.

For the fabrication of oxygen transport membranes (OTM)<sup>1</sup> or solid oxide fuel cells (SOFC), the shaping, multi-layering and co-firing of porous support structures in ceramic multilayer devices will be presented, which include the use of sacrificial templates (pore former) in extrusion<sup>2,3</sup> or phase inversion tape casting<sup>4</sup>. The correlation between the fabrication, the microstructure of the porous support structures and key performance parameters, such as gas transport, mechanical properties, thermal stability or electrical conductivity in the final ceramic multilayer structures and devices will be shown. Finally, a brief outlook on recently started R&D activities with highly porous ceramic structures will be presented, including novel concepts for the structuring of adsorbents in gas separation and storage.

### References

1. D.K. Ramachandran, M. Sogaard, F. Clemens, J. Gorauskis, A. Kaiser, Fabrication and performance of a tubular ceria based oxygen transport membrane on a low cost MgO support, *Separation and Purification Technology* 147 (2015) 422–430.
2. D.K. Ramachandran, F. Clemens, A.J. Glasscock, M. Sogaard, A. Kaiser, Tailoring the microstructure of porous MgO supports for asymmetric oxygen separation membranes: Optimization of thermoplastic feedstock systems, *Ceram. Int.* 40 (2014) 10465–10473.
3. A.B. Haugen, J. Gorauskis, A. Kaiser, M. Sogaard, Graphite and PMMA as pore formers for thermoplastic extrusion of porous 3Y-TZP oxygen transport membrane supports, *J. Eur. Ceram. Soc.* 37 (2016) 1039–1047.
4. S. Cheng, H. Huang, S. Ovtar, S.B. Simonsen, M. Chen, W. Zhang, M. Sogaard, A. Kaiser, P.V. Hendriksen, C. Chen, High-performance microchanneled asymmetric Gd FeO<sub>3-δ</sub>-based membranes for oxygen separation, *ACS Appl. Mat. and Interf.* 8 (2016) 4548–4560.