3D Printed Activated Carbon and Application in Adsorption Processes

H. Steldinger[a], M. Scherle[b], J. Gläsel[a], U. Nieken[b], B.J.M. Etzold[a]

[a] Ernst-Berl-Institut für Technische und Makromolekulare Chemie, Technische Universität Darmstadt, Darmstadt, Germany

[b] Institut für Chemische Verfahrenstechnik, Universität Stuttgart, Germany

In adsorption processes a combination of several material parameters need to be optimized and combined for the adsorbent. Geometric dependent parameters like permeability and conductivities could be predefined in an excellent manner through rapid prototyping techniques and give access to new shapes of activated carbons despite the traditional ones (pellets, fibers, honeycombs) [1, 2]. Nevertheless, 3D printing of carbonaceous material is currently limited to graphite/graphene materials with low porosity and often as composite e.g. with a binder [3]. Here we present a methodology for rapid prototyping of highly porous carbon relying on stereolithographic 3D printing of a DVB/PETA copolymer in combination with a porogen for additional meso-/macropores, oxidative stabilization, pyrolysis and CO_2 activation. Open-cell-structures based on different unit cells like tetragonal, gyroid or diamond were printed with minimal lateral resolution of approx. 10 µm and specific surface areas above 2000 m^2g^{-1}. In electro swing adsorption, the structures demonstrated to combine excellent hexane uptakes with fast and efficient solvent recovery by direct heating. In methanol adsorption studies for heat pump application, superior thermal conductivity combines with excellent permeability.

1. C. Busse, H. Freund and W. Schwieger, *Chemical Engineering and Processing - Process Intensification*, 2018, **124**, 199-214.
2. A. Avril, C. H. Hornung, A. Urban, D. Fraser, M. Horne, J. P. Veder, J. Tsanaktsidis, T. Rodopoulos, C. Henry and D. R. Gunasegaram, *Reaction Chemistry & Engineering*, 2017, **2**, 180-188.
3. H. Korhonen, L. H. Sinh, N. D. Luong, P. Lehtinen, T. Verho, J. Partanen and J. Seppälä, *physica status solidi (a)*, 2016, **213**, 982-985.