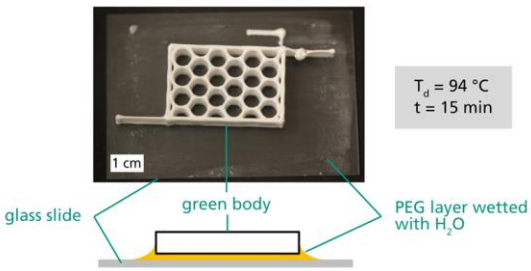
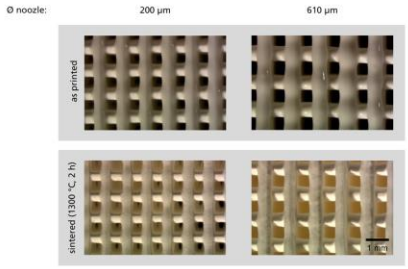
3D printed highly porous ceramic filters

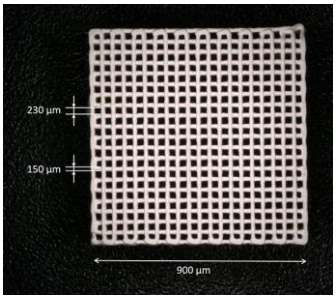
Ceramic materials are particularly suitable for manufacturing filters because they are resistant to high temperatures and chemicals. KIT developed a ceramic paste that allows high-resolution 3D printing of fine structures, in particular porous structures such as filters or catalist substrates.

Description of the technology

Scientists at the Institute of Mechanical Process Engineering and Mechanics (MVM) at KIT have developed novel ceramic pastes based on capillary suspensions whose characteristics are optimally adapted to the direct ink writing process. The ceramic paste is applied layer by layer with a movable nozzle and forms the green body. During pressing through the fine nozzle, the particle network of the capillary suspension is completely disrupted, and the paste becomes thin. However, the special composition of the suspension ensures that the particle network is rebuilt immediately after leaving the nozzle, resulting in a high degree of shape accuracy of the printed structures. In order to prevent cracks or deformations during drying, printing is carried out on a PEG-coated glass plate, which is then wetted with distilled water and dried in the oven, including the green body. The PEG layer solvated by the water melts and allows the specimen to slide smoothly on the substrate.







Innovation and advantages of the offer

The invention enables the manufacture of complex ceramic bodies with high porosity and high mechanical strength. Due to the special properties of the paste, ceramic structures with very fine strut or lines of > 50 micrometers can be realized. The printed struts are open-pored (porosity > 50 percent) and the pore size can be set between 0.5 and 50 micrometers. Thanks to the special drying technology, defects are avoided.

Non-fusion Applications

The technology was used at KIT in high-temperature environment of a nuclear fusion reactor to extract fine particles (resulting from abrasive materials) from the gases circulated through the reaction chambers. Ceramic filters are particularly preferred over e.g. metal filters in high temperature environments or aggressive chemical environments. The dimensions of the pores can be precisely defined between 0.5 and 50 micrometers.

EUROfusion Heritage

The technology was not specifically developed for fusion applications, but its TRL was advanced by application in the high-temperature environment of nuclear fusion installations at KIT. More conventional metal filter inserts would typically weaken at high temperatures and thereby lose the desired precise dimensions of the filtering pores. Ceramic filters do not suffer from that problem but could previously not be produced at the required precision.

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