Origin of the springback effect in ambient pressure dried silica aerogels

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Ambient pressure dried silica aerogels exhibit an interesting phenomenon referred to as springback effect (SBE). This effect enables porosities comparable to aerogels produced by supercritical drying (SCD) and shows a surprisingly large volume change for a ceramic material. The material might shrink up to half its size, while drying at ambient pressure (APD), expanding afterwards to almost its original size. This reversibility is often achieved by silylation of the surface of the gel, which is done by surface modification with i.e. trimethylchlorosilane (TMCS). Contrary, supercritical drying avoids the liquid-vapour interfaces, bypassing the capillary stresses of the wetgel, that would lead to shrinkage of the material [1].

The efficiency of the SBE varies upon aging, heat treatment and surface modification and therefore different processing parameters have to be studied for silica aerogels to predict the behaviour and transfer this knowledge to other material systems. According to literature, the springback effect is caused by repelling of the alkyl groups of the material, requiring a strong and flexible network to disengage the silyl groups. A small activation energy (temperature) as well as a low crosslinking degree are often required [2]. The nanostructure of the aerogel skeleton can be determined by small-angle X-ray scattering (SAXS). We hypothesize that the structure of this network is linked to the springback effect and try to prove or disprove common theories of this phenomenon using SAXS and further characterization methods.

Since incomplete springback behaviour can lead to dense materials not comparable to super critically dried gels or even fractured samples, understanding this effect is a key in the synthesis of ambient pressure dried aerogels. This might ultimately lead to continuous processing of the material with defined geometry, microstructure and stability.

Acknowledgements, References:

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