Cellulose Aerogels

Sandra Hoepfner, Barbara Milow, Lorenz Ratke
DLR, Institut für Materialphysik im Weltraum, Linder Höhe, 51147 Köln, Germany
E-Mail: Barbara.Milow@dlr.de

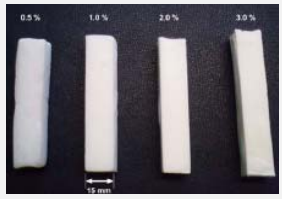
Motivation

Production of a nano-structured fibrous material being

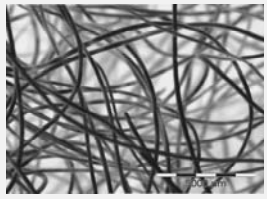
- bio-degradable
- ultra light weight
- open porous

Applications:
nano-textiles, super-isolation mat, ultra-filter paper, super-light and super-insulating space suit

monoliths

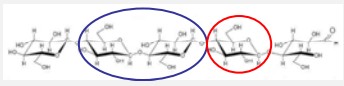


fibres

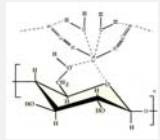


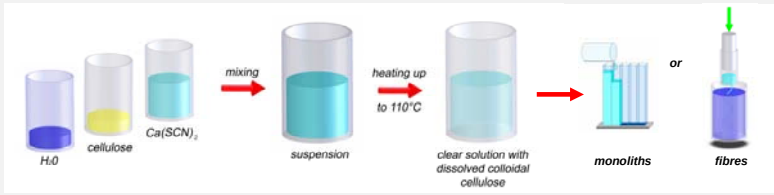
Synthesis

Dissolving of raw cellulose in salt-hydrate melts (e.g. $Ca(SCN)_2$ and water) at 110 °C into their nano-fibrils:



=> coordinative bonding



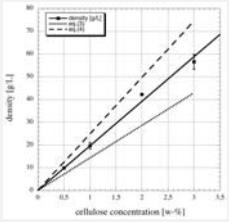


Cooling of the colloidally dissolved cellulose establishes contacts and connections until a fibrillar felt is formed during gelation.
Gelation temperature ~ 80°C.
Regeneration, washing and aging in Ethanol.
All gels are dried super-critically after CO_2 solvent exchange.

Characterization and Results

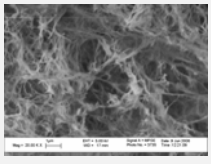
Monoliths[1]

Density [g/L]	10 – 60
Specific surface area [m²/g]	200 220

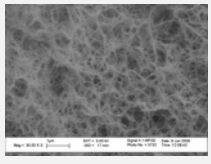


Density is proportional to cellulose concentration.

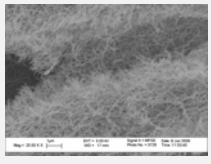
Lowest density is 8 times higher than the density of air at room temperature!



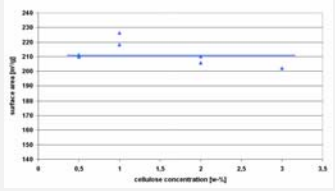
SEM picture of an aerogel with 1-wt% cellulose.



SEM picture of an aerogel with 2-wt% cellulose.



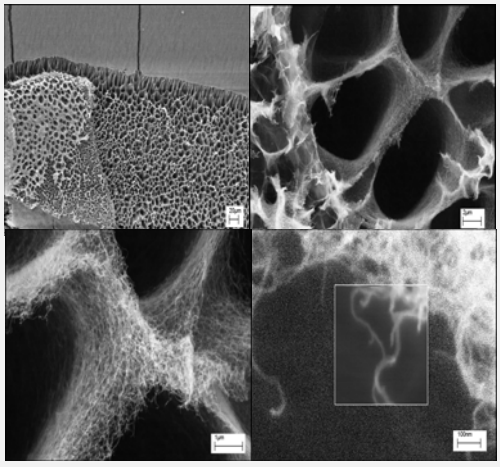
SEM picture of an aerogel with 3-wt% cellulose.



The specific surface area is a constant and independent of the cellulose concentration.

Fibres[2]

Density [g/L]	120
Specific surface area [m²/g]	180
Fracture strength [MPa]	1.4 ± 0.2
Elongation at fracture [%]	9.3 ± 6.9
Tension strength [km]	1.2 ± 0.2



SEM pictures of a cellulose aerogel fillament with 3-wt% cellulose at different magnifications.

Wet spinning produces open porous fibers with
- mesoporous sponge structure and
- nanoporous cell walls.

[1] S. Hoepfner, L. Ratke, B. Milow, Cellulose, 15 (2008) 121-129.
[2] S. Hoepfner, L. Ratke, Scripta Mat. (2008) submitted.

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