

Aerogels as Space thermal/acoustic protection systems



UNIVERSIDADE DE COIMBRA

Luisa Durães*, António Portugal

University of Coimbra – Department of Chemical Engineering

CIEPQPF – Chemical Process Engineering and Forest Products Research Centre

*luisa@eq.uc.pt, +351 239798737



FCTUC DEPARTAMENTO DE ENGENHARIA QUÍMICA
FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE DE COIMBRA



Gabinete de Promoção dos Programa Quadro ID&I



Topics that we are interested in

Space technology

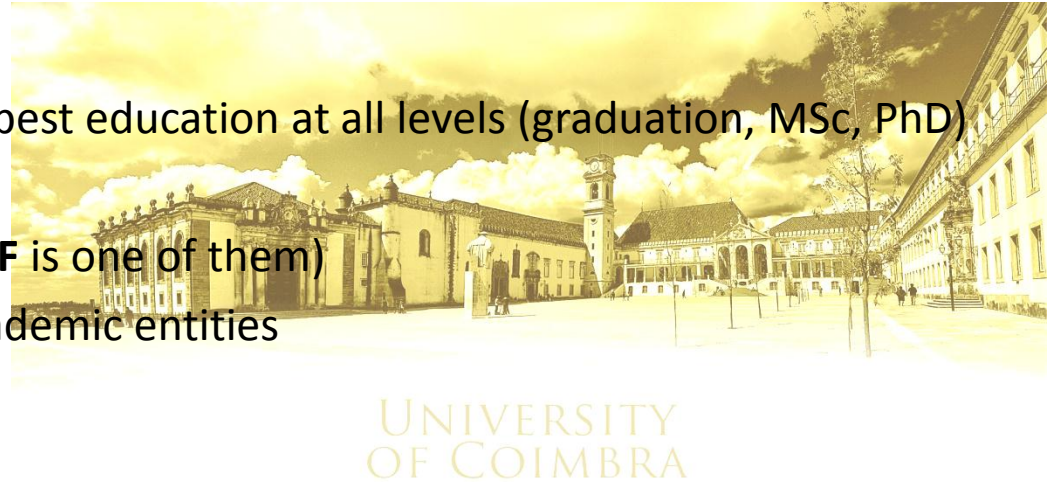
- COMPET-1-2015: Technologies for European non-dependence and competitiveness
- COMPET-3-2015: Bottom-up space technologies at low TRL



Presentation of the organisation

University of Coimbra (UC)

- Cutting-edge research to assure the best education at all levels (graduation, MSc, PhD)
- 8 Faculties and 25434 students
- Integrates 47 research units (**CIEPQPF** is one of them)
- Has strong connections with non-academic entities
- Word Heritage, since 2013



CIEPQPF research centre

- 4 research groups (Particles, Polymers and Biomaterials Technology (PPB); Process Systems Engineering (GEPSI); **Computing, Statistics & Materials (CEM)**; Environment, Reaction, Separation and Thermodynamics (GERST))
- 43 integrated members
- 41 on-going research projects (funded by FCT, QREN, CE or by the national industry)
- ≈60 grant holders (PhD students, projects researchers)



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Presentation of the organisation

Competencies (highlights) of CEM group

Study of new materials through a combination of theoretical and experimental approaches.

Nanomaterials – **Sol-gel** technology and other **soft solution approaches** for synthesis of different Si/metal oxides and hybrid **aerogels** and **nanoparticles** (silica based, iron oxides, zirconia, zinc oxide)

Energy – Biofuels; Combustion and detonics

Molecular modeling and simulation by high performance computing – Ab initio, DFT, and molecular dynamics methods

Reference projects

- European Project **FP7-SPA**.2011.2.2-02 – Space critical technologies: AerSUS – Aerogel European Supplying Unit for Space Applications (Grant agreement #284494)
- European Project **FP7-PEOPLE**-2010-ITN: MANANO - Manufacturing and Applications of Nanostructured Materials (Grant agreement #264710)
- **ESA** contract AO/1-6872/11/NL/CP: AAM – Adaptation of Aerogel Materials for Thermal Insulation
- R&D **FCT** project: PTDC/EQU-EPR/099998/2008 GelSpace – Silica based aerogels for insulation of Spatial devices

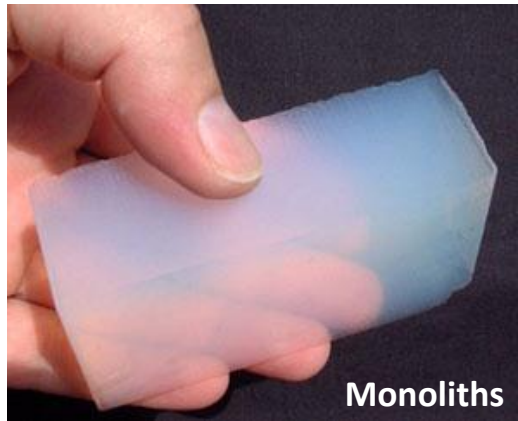


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Silica Aerogel – what is it?

Aerogel – synthetic porous ultralight nanostructured material derived from a gel, in which the liquid component of the gel has been replaced with a gas. Usually the liquid is removed by drying under supercritical conditions.



<http://www.aerogel.org>

<http://www.buyaerogel.com>

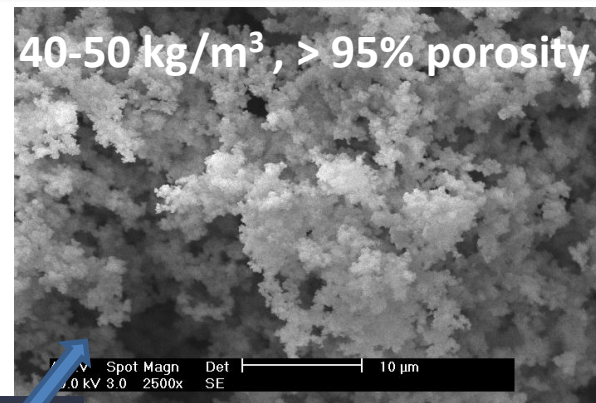
Silica based aerogels achievements at UC



oven



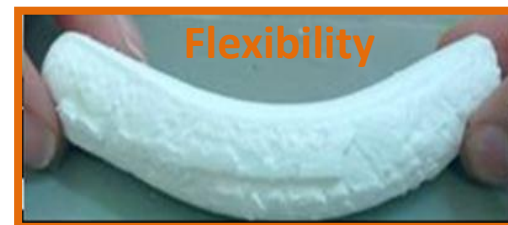
microwaves



APD



HTSCD

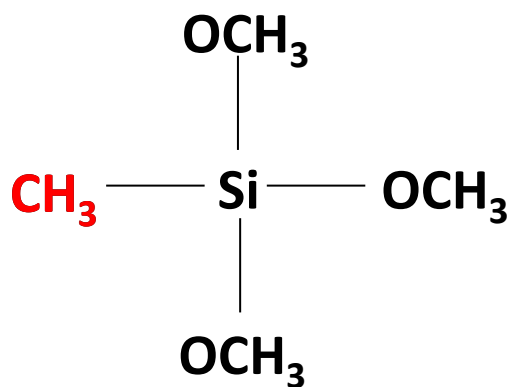


Flexibility

Young's modulus: 1-8 kPa



LTSCD



MTMS

$k = 0.03\text{-}0.04 \text{ W}/(\text{mK})$

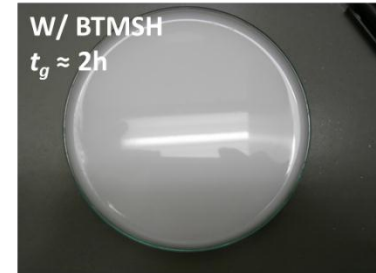
$A_s = \sim 500 \text{ m}^2/\text{g}$

$CA = \sim 140^\circ$

Durães et al., *J. Nanosci. Nanotechnol.*, 12, 2012, 6828–6834.
Ochoa et al., *J. Sol-Gel Sci. Technol.*, 61, 2012, 151–160.
Durães et al., *Mat.-wiss. u. Werkstofftech.*, 44, 2013, 380–385.
Matias et al., *NanoStudies*, 7, 2013, 145–160.

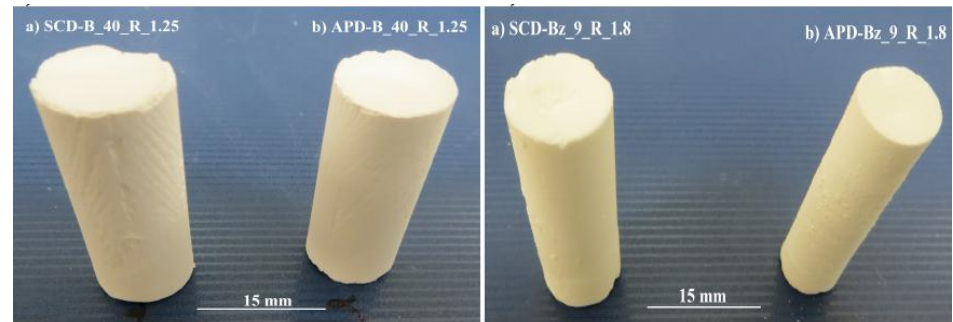
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Scale-up of gels/aerogels



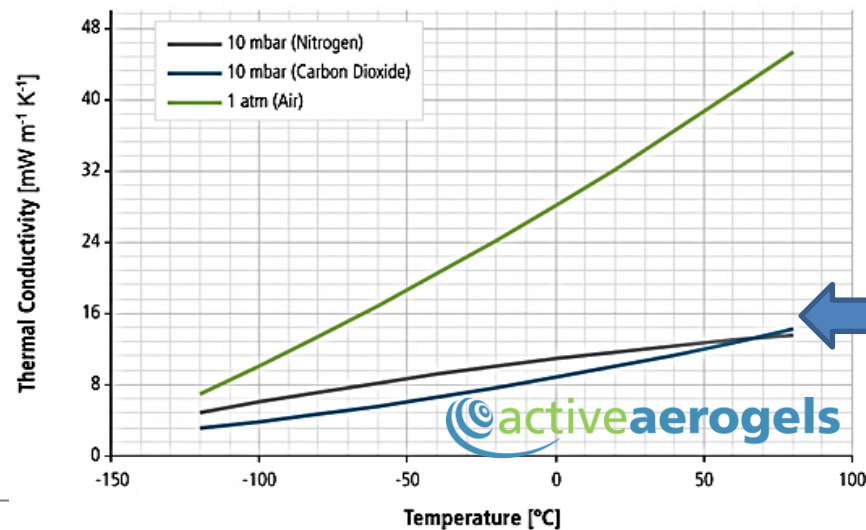
Adding of co-precursors with reinforcing bridges/chains

Adding a polymer phase:
TMOS/(BTMSH or BTESB)/TMSPM



Adding fibers to
MTMS aerogels

AA & UC, "Flexible Panels of Hydrophobic Aerogel Reinforced with Fibre Felts",
Patent PCT/PT2014/000053, 1.Aug.2014.



Potential ideas and partners

- *Any interest in the application of this technology in Space or in non-Space sectors is welcome!*
- *Tailored aerogels for the application (not only silica-based).*
- *Potential for further developing of aerogels is huge, due to the high versatility of the starting chemical systems.*

