Aerogels

The Future of Thermal Insulation for Space Applications

activespace technologies

making space a global endeavour

Contents

Company Profile

Founded in 2004

Staff with more than 15 years of experience in mechanics and electronics

Over 10 years of research and development experience in the aerospace industry

Role

Offering high value services to R&D institutions, systems integrators, and SMEs

Fostering edge products development and technology transfer

Mission Statement

Providing mechanical and electronics engineering state of the art expertise

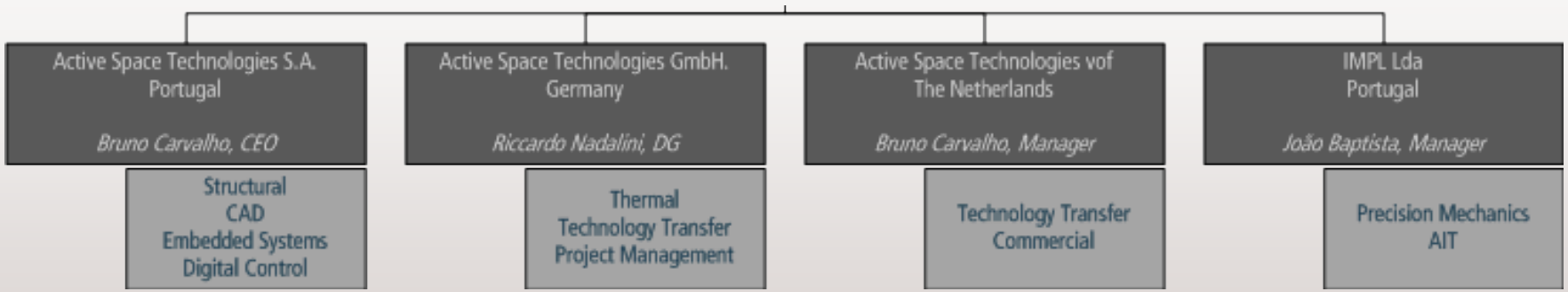
Offering turn-key subsystems, supplying the whole value-chain from requirements definition, CAD services, and modelling up to manufacturing and AIT

Company Profile

Offices	
Coimbra, Portugal	
Berlin, Germany	
Noordwijk, The Netherlands	

Legal Status
Private Capital
Small and Medium Entreprise (SME)
Shareholders of CEIIA

Organigram



Services

Conceptual Design	Engineering	Manufacturing
3D CAD Design Catia, SolidWorks	Thermal Analysis ESARAD / ESATAN, Fluent	CAM Design
2D Drawings, built-to-print	Structural Analysis Patran / Nastran	Precision CNC
	CFD Fluent	
	Electronics	
	Control	
	Materials R&D	

Technology Transfer

Project Management

Materials

Market opportunities

- Proof of Concept apps, innovative materials
- Benchmarking competitors and opportunities
- Promotion Space Agencies, End-Users

Development

- Requirements definition for apps and missions
- Test Plans relevant assessments, test sequence
- Design and Analysis of Experiments

Qualification

- Space Compatibility assessments
- Integration integration solutions in final apps

Aerogels

- Monolithic Flexible Aerogels
- Supercritical Fluid Drying
- Tailored Properties
- Ambient Pressure Drying

Space Insulation Systems

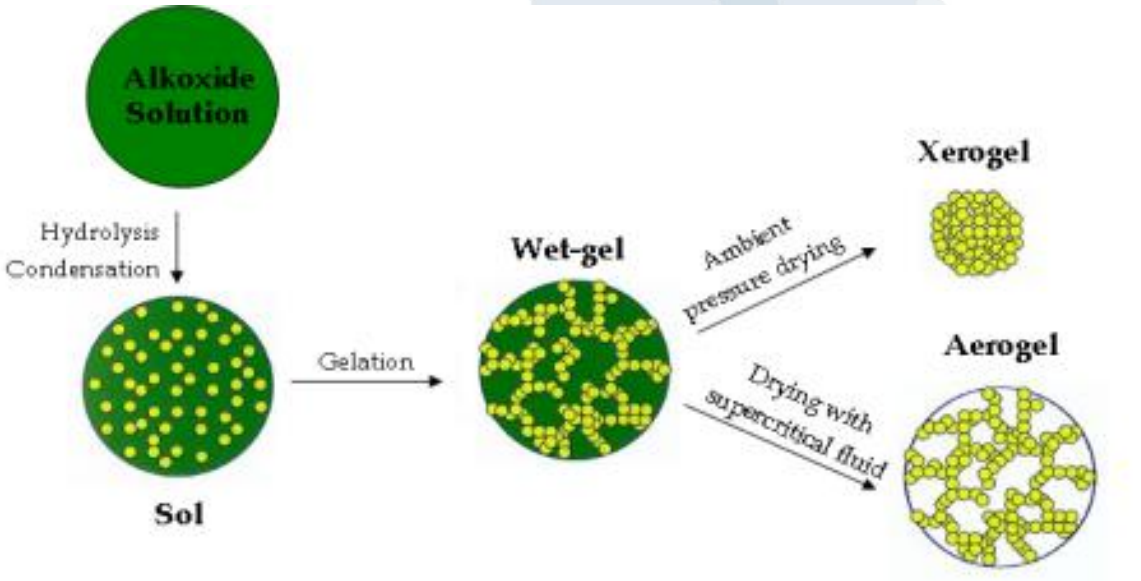
- Design aerogel-based insulation
- Manufacturing of aerogel insulation
- Performance evaluation space environments

Proof of Concept → **Development** → **Qualification** → **Marketing**

Aerogels

Aerogels

Structure and performance
Highly porous structure (~98%)
Nanoporous (2-100nm)
Lightest material known (1-100 g/L)
Superinsulation (4-25mW/mK)
Tailorability for broad range applications
Market in large expansion



Aerogels in Space Applications

Distinguish Advantages for Space Thermal Insulation

Aerogel vs. Multi-Layer Insulation (MLI):

MLI easily falls unders acess restrictions in Europe

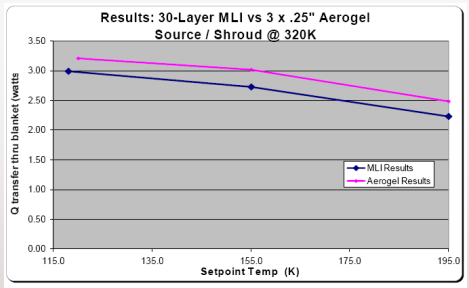
MLI has a cumbersome manufacture

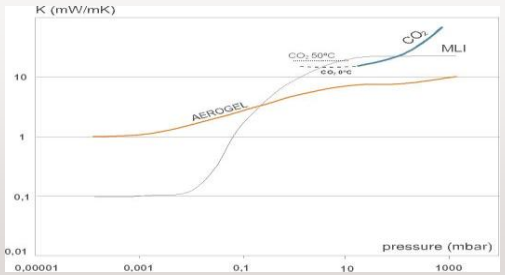
Aerogel can provide thermal insulation as a single material

Aerogel is industrially producible (greater quality assurance)

Thermal insulation for planetary landers and rovers:

MLI is not efficient in environments where the atmosphere plays a role





Source
Aerogel Enhanced Thermal Management Systems for Satellites, Shanon White, Aspen Aerogels

Insulation of cryogenic propulstion systems:

Conformational flexible aerogel blankets can provide better insulation performance than traditional foams

Benchmarking

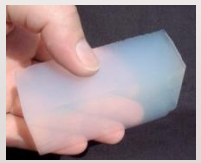
Aerogel Solutions

R&D production level:

- Rigid products
- Low maturity level
- Improved mechanical properties require expensive raw-materials

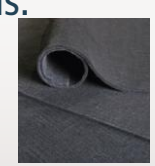

Airglass


Separex – PU Aerogel



Commercial composite solutions:

- Offer high technological maturity, superinsulation, flexible insulation
- Cause extensive, dust contamination, are heavier than non-composite aerogels


Aspen Aerogels


Cabot Thermal Wrap

Aerogels Products

Supplier	*Product*	*Thermal conductivity [W / m K]*	*Density [g / cc]*	*Min. Temp. [°C]*	*Max. Temp. [°C]*	*Material*
Aspen Aerogels	Cryogel Spaceloft Pyrogel	0.0135 0.0125 – 0.0135 0.0145 – 0.0155	0.13 0.17 0.12 – 0.17	-200 -200 -200	40 200 650	Foam-like Hydrophobic Tensile strenght 88kPa
Separex	-	0.005 – 0.02 0.0015 – 0.0085 0.0175 – 0.012	0.1 0.209 0.26	-	-	PU (monolith)
MarkeTech International Inc	-	0.004 (vac.) 0.016 (air)	0.1 (0.01 – 0.3)	-	-	Silica (monolith) Tensile strenght 16kPa
Airglass	Airglass	0.021 (20ºC) 0.2 (300ºC)	0.05 – 0.2	-	-	Silica (monolith) 60 x 60 x 2 cm³
Cabot Corporation	translucent IR opac. beds Fine particle Aerogel beds	0.018	0.090 – 0.100 0.090 – 0.100 0.040 – 0.100 0.090 – 0.100	-	-	Silica (beads / particles) Hydrophobic
NanoPore	HP-150 HT-170	0.0034 – 0.020 0.0038 – 0.021	0.015 – 0.016 0.0165 – 0.017	-273 -273	150 600	VIP

Aerogels Synthesis at Active Space Technologies

Sol-Gel Technology Laboratory

protocol: Chemical Engineering Department, University of Coimbra (FCTUC)

Synthesis:

Precursors – silica derivatives

Reaction – two-step catalysed process

Drying:

Ambient Pressure Drying – Xerogels

Supercritical Fluids Drying - Aerogels

Key properties:

Very low density (Aerogels: 50-60 g/L, Xerogels: 70-80g/L)

Low particulate contamination

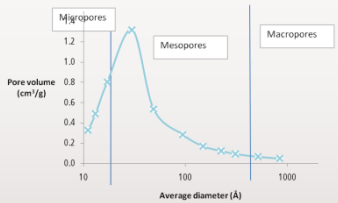
Flexibility (easy to handle and integrate) (even at -180ºC)

Low cost raw-materials

Aerogels – Product Datsheet at Active Space Technologies

Silica-based aerogels properties

Nanostructure:



Skeleton density: 1000-1200 g/L

Porosity: 93-97%

Specific Surface Area: 500-900 m^2/g

Mean pore size: 1.5-4.5 nm

Macroscopic:

Bulk Density: Aerogels – 50-60 g/L; Xerogels – 70-80 g/L

Hydrophobic: 140º static water contact angle

Particulate contamination: Very low

Thermal:

Aerogels oxidation (12% weight loss): 400-500ºC

No mass loss obersved at [500-1000]ºC

Specific heat capacity: 1.9-2.3 J/(g.ºC) (at 40ºC)

No glass transition observed [tested down to -180ºC]

Coefficient of linear thermal expansion: 1.4-1.5 (K^{-1})

Mechanical:

Elastic modulus: 5-30 kPa

Yield on compression: 7.0-7.0 kPa at 30-35%

Flexible at low temperatures – Modulus: 60kPa@-170ºC, 25kPa@0ºC

Aerogels – Thermal Insulation Systems at Active Space Technologies

Aerogel Panels – Development, Manufacture, and Integration

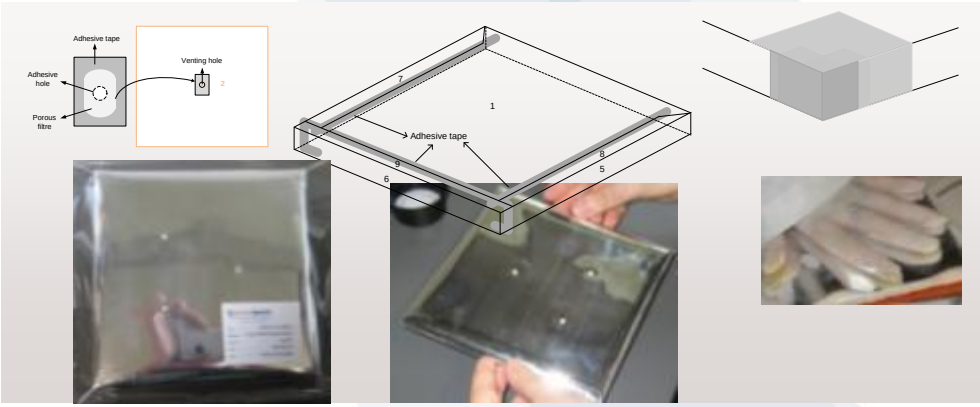
Design and Manufacturing of Aerogel Insulation Panels:

Easy handling, self-sustainability, non-brittle

Cleanliness control

Integrity at environmental changes (P, T)

Radiation control

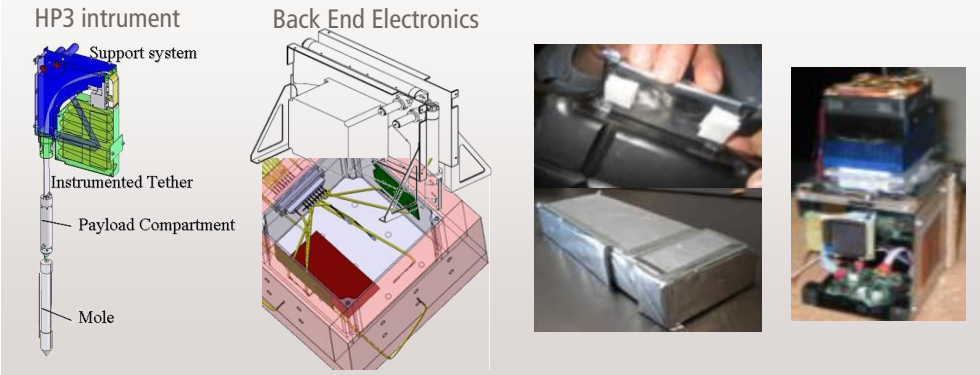


Integration and Qualifcation:

Easy integration procedures on spacecraft hardware

Space compatbility assessments

Qualification testing process



Future Perspectives

Further developments on Aerogels at Active Space Technologies

Tailorability of Aerogels Properties:

New capabilities on manufacturing and applications of nanostructured materials (Network – FP7 MANANO)

Controlled synthesis allows tailorability of aerogel properties to protect different spacecraft devices (thermal and structurally)

Exploitation of On-Earth Aerogels Applications:

- Thermal insulation: industrial and buildings
- Pharmacology: controlled drug delivery systems
- Effluents treatments: oils removal, gases capture

European Aerogels Supplying Unit for Space Applications:

Creation of a large-scale aerogels manufacturing unit

Disruptive project to replace imported MLI with European aerogel technology

Creation of an European aerogels supply chain that can extend into other industrial sectors

Contact us

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