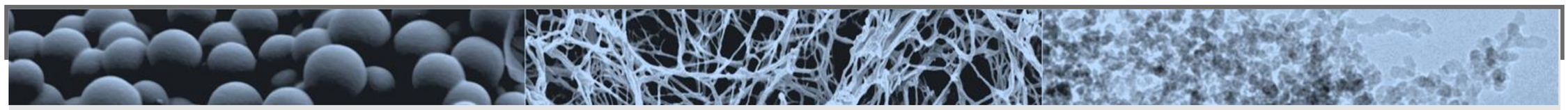
Flexible Silica Aerogels – Material Development and Characterization for the Insulation of Aircraft Cabins



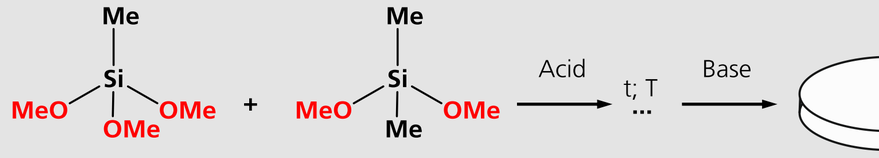
Motivation

Currently used insulation materials for aircraft cabins lead to increased fuel consumption due to humidity condensation and ice formation inside the material.

Lightweight and hydrophobic flexible silica aerogels are used as a replacement.

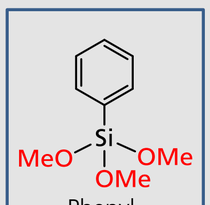
Despite remarkable properties like flexibility and hydrophobicity, flexible silica aerogels are also characterized with higher density, thermal conductivity, and flammability in comparison to non-flexible silica aerogels.

Implementation

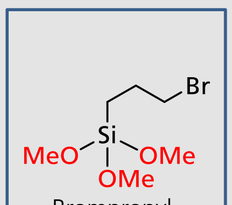


Post-synthetic treatment

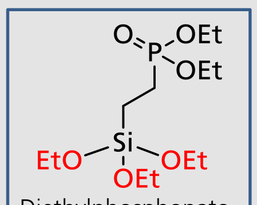
Adaptation of the Recipe



Phenyl-trimethoxysilane (**PTMS**)



Brompropyl-trimethoxysilane (**BpTMS**)

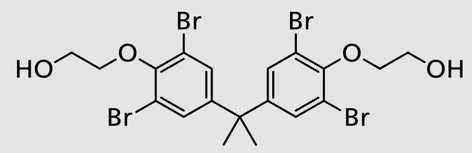


Diethylphosphonato-ethyltriethoxysilane (**DEPETES**)

Integration of fire retardants in the sol-gel process

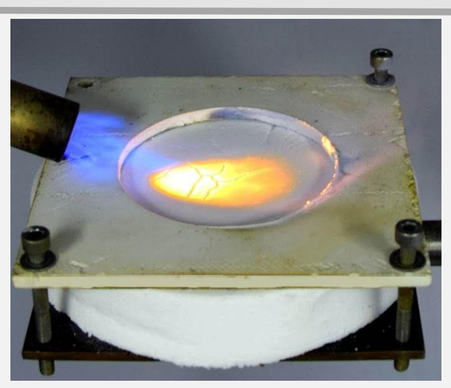
$(NH_4)_2HPO_4$

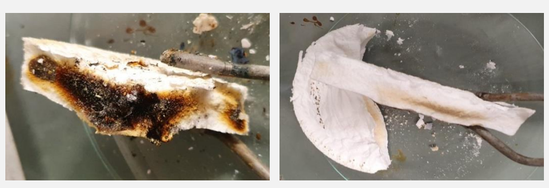
Ammonium hydrogen phosphate



Tetrabromobisphenol A bis(2-hydroxyethyl) ether (**TBBPA** derivate)

Results & Characterization



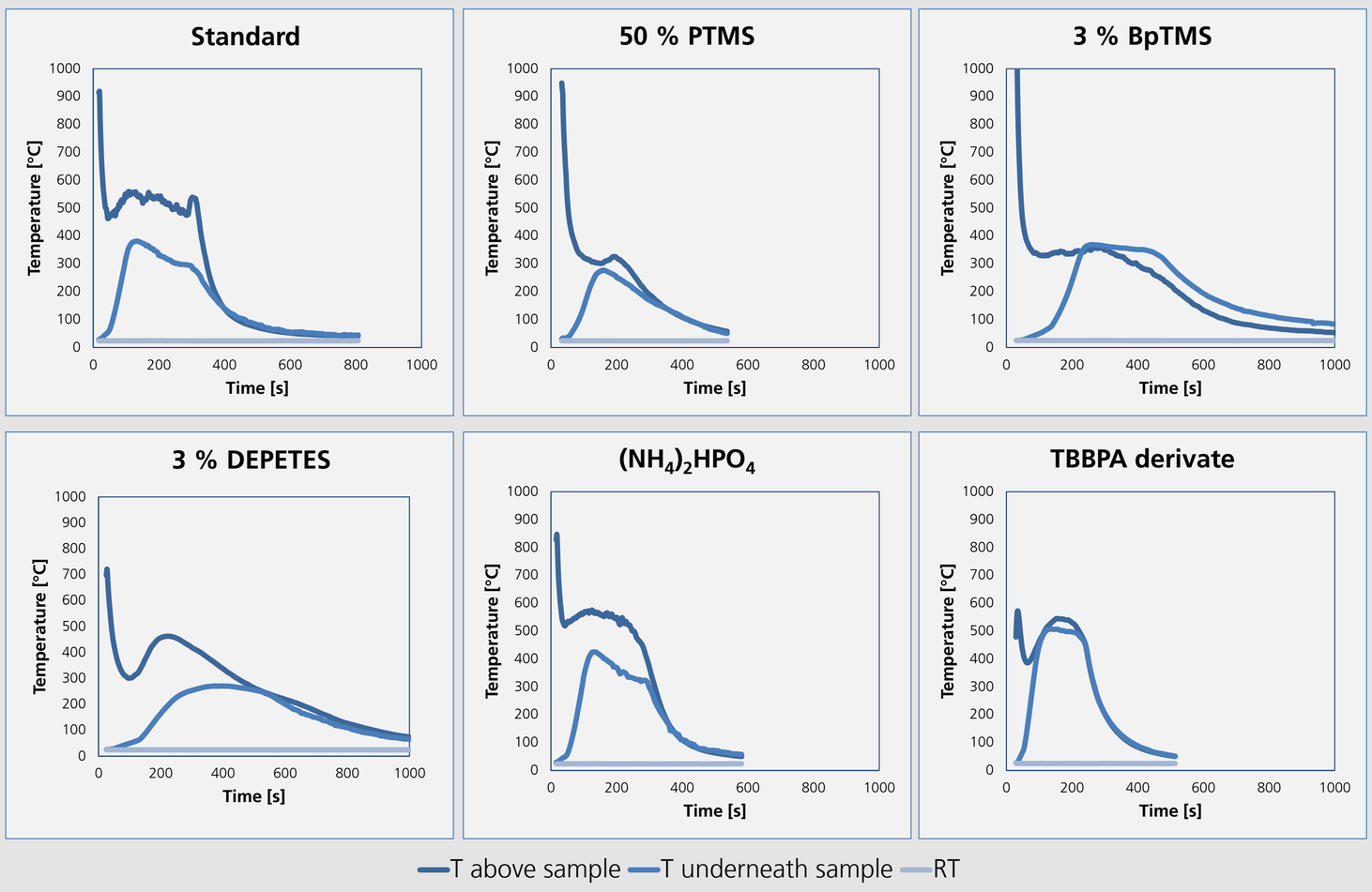


Fire-test: setup (top); standard flexible aerogel (left) and modified aerogel with DEPETES (right)

- Best results with 50 % PTMS
  - Time interval of smouldering is shorter than without modification
  - Faster cooldown to RT
- BpTMS is less recommendable as a flame retardant due to its long smouldering, cooldown and smoke duration
- Promising results with 3 % DEPETES
  - Time interval of smouldering is shorter
- Flammability of a thin layer of sprayed $(NH_4)_2HPO_4$ is comparable to standard flexible aerogel
- Post-synthetic treatment with TBBPA derivate results in faster cool down

Modification*	λ [mW/(m·K)]**	ρ [kg/m³]	Φ [%]	$t_{Afterflame}$ [s]	$t_{Cooling}$ [s]	t_{Smoke} [s]
None	33.8	117	91	3	613	> 613
50 % PTMS	35.0	256	80	10	477	477
3 % BpTMS	34.5	114	91	1	> 1000	> 1000
3 % DEPETES	33.2	126	90	9	> 1000	> 1000
$(NH_4)_2HPO_4$	33.5	145	-	1	581	> 581
TBBPA derivate	33.6	141	-	3	514	> 514

* values given in mol%, **measured *via* heat flow meter



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[1] G. Hayase, K. Kanamori, K. Nakanishi, *Journal of Materials Chemistry*, **2011**, *21*, 17077-17079.
[2] R. Fener, P. Niemeyer, *Flexible Composites Based on Aerogels*, DE102015200191A1, **2015**,.

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