Effect of different aramid fibres as reinforcement of silica-based aerogels for high-temperature thermal insulation materials

Cláudio M.R. Almeida*, Mariana Emilia Ghica, Luisa Durães

University of Coimbra, CIEPQPF, Department of Chemical Engineering, Rua Sílvio Lima, 3030-790, Coimbra, Portugal

*Presenting author: claudio@eq.uc.pt

The outstanding properties of silica-based aerogels, reaching porosities beyond 90% and densities as low as 50 kg m^{-3} [1], make them attractive insulator materials for Thermal Protection Systems (TPS), although native silica aerogels show poor mechanical strength due to their inherent thin, ceramic structural links. Thermally and mechanically stable TPS may be obtained with silica aerogel nanocomposites, reinforcing the silica matrix with a flexible fibrous organic phase able to withstand temperatures up to 500-600 ºC. Among the organic reinforcement materials, aramids are the most prominent due to their high-performance, namely the excellent mechanical strength and dimensional/thermal stability in extreme environments [2]. Moreover, the introduction of a certain amount of vinyltrimethoxysilane (VTMS) as a co-precursor typically leads to an improvement of bulk density and thermal conductivity of silica aerogels when compared with those obtained only from TEOS [3].
In this work, different aramid fibres were introduced in a previously optimised TEOS-VTMS precursor system [4]. The influence of the various fibres on thermal and mechanical properties of the resulting nanocomposites was studied. Low bulk density values were achieved (in the range 120-240 kg m^{-3}) and the most promising samples also exhibited low thermal conductivity (< 35 mW m^{-1} K^{-1}) and thermal stability up to 500-600 ºC. The introduction of aramid fibres with different lengths and chemical structures led to significant differences on shrinkage and mechanical properties of the produced aerogels.

Acknowledgements. This work was developed by University of Coimbra under the project AeroXTreme (CENTRO-01-0145-FEDER-029533) - “High-performance silica aerogel nanocomposites for insulation under extreme temperature Space environments”, co-funded by Foundation for Science and Technology (FCT) and by the European Regional Development Fund (FEDER), through Centro 2020 - Regional Operational Program of the Centre of Portugal.

References

1. Durães, L., Maia, A., Portugal, A. (2015) The Journal of Supercritical Fluids 106, 85-92.
2. Ahmad, Z., Sarwar, M. I., Wang, S., Mark, J. E. (1997) Polymer 38, 4523-4529.
3. Torres, R, Vareda, J., Lamy-Mendes, A., Durães, L. (2018) The Journal of Supercritical Fluids 147, 81-89.
4. Ghica, M.E., Almeida, C.M.R., Fonseca, M., Portugal, A., Durães, L. (2020) Polymers 12, 1278.