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Silica-based aerogels reinforced with aramid fibers for thermal insulation at extreme temperatures

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Silica aerogels belong to a class of highly porous materials (> 90%), obtained by sol-gel technology, which exhibit unique properties, such as low thermal conductivity (< 20 mW m^{-1} K^{-1}), low density (< 150 kg m^{-3}) and high surface area (500-1200 m^2 g^{-1}) [1,2]. Due to their specific properties, these aerogels present a wide range of applications in: thermal insulators, battery electrodes, catalysts, humidity sensors, adsorbents for pollutants, as well as optical, acoustic insulators and dielectric devices [1,2]. Despite their excellent and unique properties, pure silica aerogels present some drawbacks, like fragility and hydrophilic behaviour, which limit their application on a large-scale. Nevertheless, silica aerogels present high versatility for surface modification and allow easy incorporation in their structure of various compounds, such fibers, particles and polymers, for improving their mechanical, optical and thermal properties [1,3]. The proper selection of silica precursors also permits to obtain more durable aerogels with higher strength. Among the organic reinforcement materials, aramids are very promising materials due to their excellent mechanical behaviour and dimensional/thermal stability in harsh environments [4].

This project focuses on the development of fiber-reinforced silica-based aerogel nanocomposites for high-performance thermal insulation at extreme temperature/vibration conditions imposed to Space devices, especially in launch/re-entry operations and at cryogenic propulsion stages. For the aerogels preparation, different silica co-precursors in various ratios and reinforcement with different para/meta aramid fibers were tested. The aerogels´s characterization was performed in order to investigate their morphology, structure, chemical composition and thermal resistance. The most promising architecture exhibited low bulk density value (~200 kg m^{-3}), as well as low thermal conductivity (< 30 mW m^{-1} K^{-1}) and hydrophobic behaviour (Fig.1). Globally, the prepared aerogel composites presented high thermal stability up to 550-600 ºC and integrity.

(a) (b)

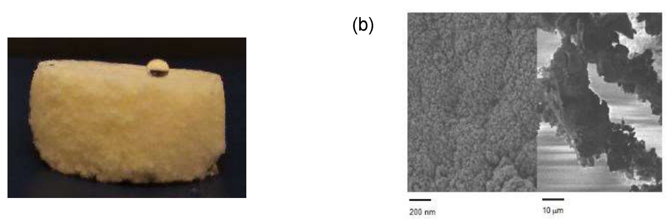

Fig.1. (a) Contact angle and (b) SEM image of aramid-silica aerogel nanocomposites

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References

[1] H. Maleki, L. Durães, A. Portugal, Journal of Non-Crystalline Solids 385 (2014) 55-74.
[2] R.B. Torres, J.P. Vareda, A. Lamy-Mendes, L. Durães, The Journal of Supercritical Fluids 147 (2019) 81-89.
[3] Lamy-Mendes, R.F. Silva, L. Durães, Journal of Materials Chemistry A 6 (2018) 1340-1369.
[4] Z. Li, L. Gong, C. Li, Y. Pan, Y. Huang, X. Cheng, Journal of Non-Crystalline Solids 454 (2016) 1-7.