Opacified Fiber Reinforced Silica Aerogels for Three Dimensional Parts

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Abstract Within this study, monolithic three-dimensional silica aerogel (SA) composite with super insulating properties are discussed. A generic part based on fiber-reinforced (FR) silica aerogel for thermal insulation of the exhaust tubing system was produced via a sol-gel-based molding process in combination with a supercritical drying using scCO2 to improve the efficiency of the catalyst system by keeping the exhaust gases as hot as possible. A thermal conductivity of 16 mW m^{-1} K^{-1} and less was measured via heat flow meter technique. In this work, we present a full cycle of the material compound design, starting with a fundamental material evaluation including aerogel optimization, opacifier influence, and the sol-casting process. The obtained generic part in shape of a half-shell for exhaust tubing insulation system is characterized under real conditions in relation to a commercially available product.
The developed material is based on pristine silica aerogel which has already been used for honeycomb structures.[1] However the aerogel's synthesis again had to be optimized for the proposed purpose as the material's homogeneity becomes highly important for the present application. The new designed aerogel composite was tested up to temperatures of more than 800 °C and exhibits surface temperatures of approx. 70 °C less than the commonly used material. Also, overshooting of temperatures cannot be seen through the material and therefore the new composite does not only protect the outside from absolute high temperatures but also from fast temperature changes and short term peak temperatures on the inside.[2]

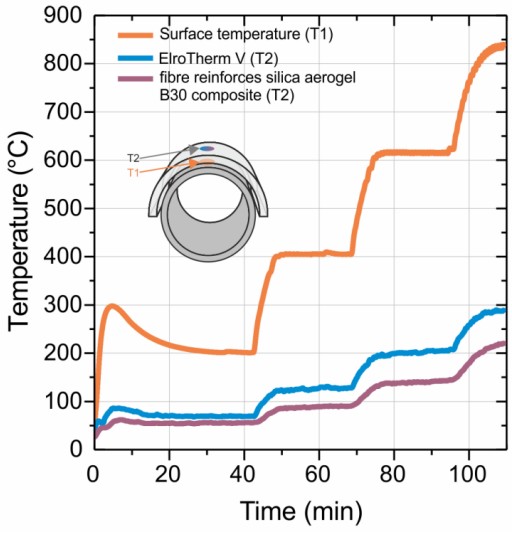

Figure: Surface Temperature of the aerogel composite in comparison to the commercial material.

References:

1. Berkefeld, A., M. Heyer, and B. Milow, *Silica aerogel paper honeycomb composites for thermal insulations.* Journal of Sol-Gel Science and Technology, 2017. **84**(3): p. 486-495.
2. Heyer, M., et al., *Advanced Opacified Fiber-Reinforced Silica-Based Aerogel Composites for Superinsulation of Exhaust Tubing Systems in Semi-Stationary Motors.* Materials, 2020. **13**(12): p. 2677.