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PII: S1359-835X(17)30269-5
DOI: http://dx.doi.org/10.1016/j.compositesa.2017.07.012
Reference: JCOMA 4732

To appear in: *Composites: Part A*

Received Date: 18 April 2017
Revised Date: 17 June 2017
Accepted Date: 12 July 2017

Please cite this article as: Yin, R., Cheng, H., Hong, C., Zhang, X., Synthesis and characterization of novel phenolic resin/silicone hybrid aerogel composites with enhanced thermal, mechanical and ablative properties, *Composites: Part A* (2017), doi: http://dx.doi.org/10.1016/j.compositesa.2017.07.012

Synthesis and characterization of novel phenolic resin/silicone hybrid aerogel composites with enhanced thermal, mechanical and ablative properties

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Abstract: A novel lightweight phenolic resin/silicone (PR-Si) hybrid aerogel composite was fabricated through vacuum impregnation using PR-Si hybrid aerogels as matrix and low density (0.184 g/cm^3) carbon-bonded carbon fibre as 3-dimensional reinforcement. The PR-Si hybrid aerogels was synthesized through a facile sol-gel polymerization, accompanied by solvent exchange and ambient pressure drying from a mixture of PR and methyltrimethoxysilane (MTMS) with ethylene glycol as the porogen and hexamethylenetetramine as the catalyst. The hybrid aerogels possess hierarchically micro-meso-macroporous structure and higher thermal stability than that of the pristine PR aerogels. The obtained aerogel composites exhibit low density (0.312-0.356 g/cm^3), high compressive strength (0.76-4.08 MPa), low thermal conductivity (0.098-0.240 W/(mK)), and good thermal ablative and insulative properties in oxyacetylene flame simulated high temperature environment (linear ablation rates as low as 0.073 mm/s and internal temperature peaks below 200 °C at 38 mm in-depth position as the surface temperature approximately 1800 °C).

Keywords: Hybrid; 3-Dimensional reinforcement; Mechanical properties; Thermal properties.

1. Introduction