Development and Characterization of graphene modified Cellulose derived carbon aerogels for thermal insulation

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Carbon aerogels are highly porous carbon 3D structures which offer possess very good properties, such as high electrical conductivities, with very low densities. These properties give them promise in applications such as sensors, absorbents, catalyst supports and EMI shielding. In addition, due to their light-weight and thermal properties, these carbon porous structures also emerge as highly promising to be used for thermal protection of high temperature systems.

Herein, graphene-cellulose derived carbon aerogels were produced by the carbonization of freeze dried cellulose gels and graphene oxide was used as an additive to modify their structure. By controlling the synthesis conditions, the dimensions of the interstitial space could be tuned from 15 nm to some microns and a porosity of up to 98% was achieved. The structure and thermal conductivity of the fabricated aerogels were investigated and their performance as high-temperature insulators was evaluated.

Their thermal diffusivity was obtained using Laser flash apparatus in an argon atmosphere, the thermal conductivity was found for the carbon aerogel with added graphene oxide was determined to be 0.23W/ mK at 1500 °C, whereas without graphene oxide was 0.48 W/ mK. This difference in performance was attributed to a different porosity, as revealed by μ-CT and SEM.

In addition, compared with commercially available cellulose derived carbon felt, the carbon aerogel modified with graphene oxide shows three to four times higher values of thermal conductivity measured under the same experimental conditions, suggesting that these novel carbon aerogel structures can be commercially competitive for applications as high temperature insulators. Moreover, the microstructure of low-density felt was compared with carbon aerogels using μ-CT, this work elucidates the effect of graphene oxide on structural factors and thermal properties accordingly. The Rosseland approximation was used to explain the observed trend in thermal conductivity, which give sight into the mechanism of heat energy transmission in porous materials and suggests the rules of structure to control the thermal conductivity for a wider range of applications. There is three heat transfer mechanism based on systematic studies of thermal properties of carbon aerogel with defined morphology under different external conditions. The parameters identified for thermal conductivity reduction are material structure, density, and high infrared extinction coefficient based on these mechanisms which are helpful in understanding the heat transfer process.