Public Abstract
First Name:Andrew
Middle Name:Karl
Last Name:Gillespie
Adviser's First Name:Peter
Adviser's Last Name:Pfeifer
Co-Adviser's First Name:
Co-Adviser's Last Name:
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Title:PROPERTIES OF ADSORBED HYDROGEN AND METHANE FILMS ON NANOPOROUS SOLIDS

The environmental impacts and costs of fossil fuels necessitate the development of clean, renewable fuel sources for vehicular applications. Hydrogen based systems, with water as their byproduct, have zero carbon emissions, which mitigates the negative effects of using conventional fossil fuels. The main drawback of hydrogen as a fuel is its low energy density at ambient pressures and temperatures. Therefore, it is necessary to increase the volumetric energy density of hydrogen before it can be considered as a practical option.

Conventional storage methods for hydrogen include compression and liquefaction, which require high pressures or low temperatures. Compressed gas systems require tanks with massive walls which reduce spatial and mass efficiency and thus, vehicle performance. In order to achieve driving ranges that compete with those of fossil fuels, it is necessary to develop a low-pressure, high-capacity storage technology that also addresses the temperature, pressure, weight, and volume constraints. To achieve this, we investigate the storage capacity of nanoporous carbon materials, which are capable of densifying a high volume of hydrogen on their surfaces through the process of adsorption.

In this work we investigated methods to tune the pore geometries and increase the interaction energy between the stored gas and the surface of the adsorbent material in an effort to optimize the storage capacity. We found that very dense adsorbed hydrogen and methane films form on the surfaces of our carbon materials. The adsorbed hydrogen films reached a density exceeding 100 g/L, which is higher than that of liquid hydrogen. Thermal management is also an important factor to consider when designing storage tanks based on adsorption technology. With this in mind, we also studied the heat released during adsorption. We were able to measure microscopic parameters of the adsorbed film, which lead to improved estimates of the heat released during adsorption. This will assist in optimizing the thermal properties of on-board storage tanks in the future.