IV.C.1o Novel Hydrogen Storage Media through Nanostructured Polymeric Materials

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On-board hydrogen storage technology will be critical in future transportation applications, such as H_2-powered fuel cell vehicles, in the new hydrogen-based economy. To be practical, the storage system must have a gravimetric capacity of at least 0.06 kg H_2/kg and a volumetric capacity of 0.045 kg H_2/L at ambient temperature. Furthermore, the adsorbent cost must be less than $4/kWh to be commercially viable. No current technology meets these goals.

The objective of this project is to investigate nanostructured polymeric materials (NPM) as the new hydrogen storage adsorbents for transportation applications. This approach is based on the recent success of collaboration between Argonne National Laboratory and The University of Chicago in developing alternative porous polymers for on-board H_2 storage. In our preliminary study, we found that one polymer sample demonstrated relatively high hydrogen uptake capacity (0.024 kg H_2/kg gravimetric, 0.023 kg H_2/L volumetric) at room temperature and 50 bar H_2 pressure. Theses values correspond to 40% and 51% of DOE's respective targets for 2010 and they are among the best for non-dissociative adsorbents, to our knowledge. The polymer demonstrated excellent H_2 adsorption reversibility and stability. It has a lightweight framework, requires little energy for H_2 extraction, and can be produced inexpensively at large scales.

In this research, our approach to improve these materials and explore new polymer adsorbents to meet the H_2 storage capacity target set by DOE for 2010 will combine a number of activities. We will apply a unique set of design principles obtained through our preliminary study to guide new materials research. In addition, we will conduct advanced X-ray and neutron characterizations and theoretical modeling to gain an in-depth understanding of the nature of the H_2-polymer interaction using state-of-the-art facilities such as the Advanced Photon Source, Intense Pulsed Neutron Source, and Computational Resource Center at Argonne National Laboratory. The knowledge gained through the structure-property relationship study will guide the further optimization of our polymer design and synthesis, as well as post-synthesis treatment. We will also carry out scale-up analysis and develop a roadmap for commercialization with potential industrial partners.

If successful, the project could lead to low-cost, high-capacity hydrogen storage materials that can be mass-produced within the existing industrial infrastructure. Argonne National Laboratory is the primary lead on the project with the participation of The University of Chicago as a subcontractor.