Hawaiʻi Natural Energy Institute Research Highlights

Advanced Materials

Development of Novel Air Filtration Materials

<u>Objective and Significance</u>: The objective of the project is the design, synthesis and characterization of novel, reversible high-performance acidic gas (SO_x, NO_x and H_2S) contaminant absorbent materials. The materials under development will enable fuel cell vehicles to be efficiently operated under harsh atmospheric air environments. If successful, sorbents under development will assist the fuel cell filter industry and reduce environmental contamination from hazardous absorbent waste.

<u>Background</u>: Current state-of-the-art gas purification technologies for acidic gas capture based on metal oxides and hydroxides do not meet all the performance requirements of today's gas purification in terms of sorption: kinetics, capacities, selectivity, and reversibility. This leads to large volumes of polluted absorbent waste. This situation can be expected to worsen in the future with the increased use of fuel cell vehicles that require abundant efficiently purified air as oxygen source.

<u>Project Status/Results</u>: The sorbent classes under development include ionic liquids and ionic salts. The sorbent material properties are optimized through a combination of a careful selection of reactants and modification of the sorbent cation and anion groups. For instance, metallo ionic liquids with a high content of the small, highly charged acetate and croconate groups and transition metal ions with expandable coordinative environments are being designed, synthesized and characterized.

Nano confinement of the absorbents in highly porous materials is being performed to increase acidic gas-sorbent interactions and hence gas sorption performance. Nano confinement is especially critical for ionic liquids absorbents since they have high viscosity, which limit gas diffusion distances into the bulk of the material. We have physically deposited thin films of 1-ethyl-3-methyl imidazolium acetate ionic liquid onto activated carbon that remain intact during exposure to SO_2 and/or NO_2 contaminated air streams. The sorbents being developed also have relevance in other applications requiring acidic gas (SO_x, NO_x, and H_2S) contaminant mitigation, including flue gas cleaning and natural gas purification.

We finalized the SO_2 sorption performance testing of the synthesized and characterized novel metallo-ionic liquids (MIL): $Zn_3[OAc]_8[C_2mim]_2$, $Mg_4[OAc]_{10}[C_2mim]_2$, and $Fe_4[OAc]_{10}[C_2mim]_2$ supported on nanoporous activated carbon (AC). The Mg-based MIL-AC sorbents had the highest SO_2 breakthrough time and capacity followed by Zn-based sorbent (Figure 1). The sulfur dioxide tests were performed at 10 ppm in simulated air, using a custom-designed and fabricated filtration materials test stand, at 1.5 LPM and relative humidity of 40-50%.

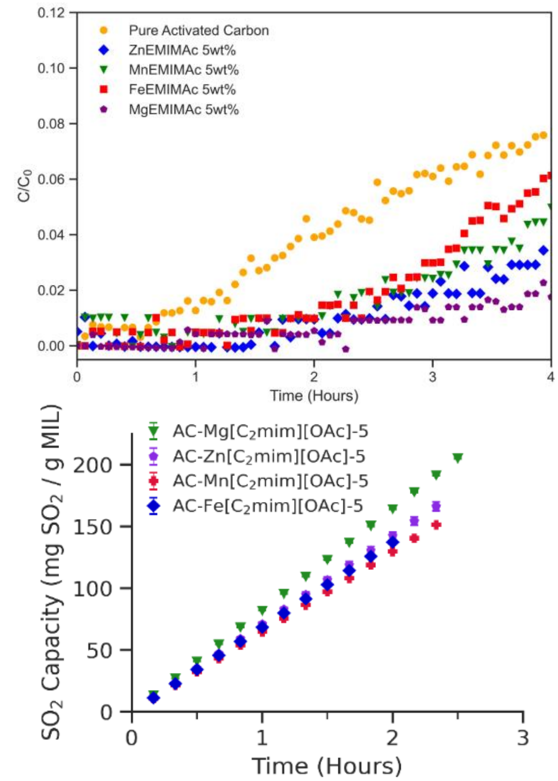

Figure 1. Comparative studies of SO_2 absorption for 5 wt% MIL-AC under a challenge gas of 10 ppm SO_2.

Further work involves integration of the $Zn_3[OAc]_8[C_2mim]_2$ and $Mg_4[OAc]_{10}[C_2mim]_2$ with commercial filter media to form improved hybrid filters for multiple gas contaminant removal and investigating capability of the metallo ionic liquids for H_2S removal.

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Contact: Godwin Severa, severa@hawaii.edu

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Hawaiʻi Natural Energy Institute | School of Ocean & Earth Science & Technology
University of Hawaiʻi at Mānoa, 1680 East-West Road, POST 109 • Honolulu, HI 96822
Phone: (808) 956-8890 • Fax: (808) 956-2336 • www.hnei.hawaii.edu