PROJECT FACTS

UNIVERSITY OF KENTUCKY CENTER FOR APPLIED ENERGY RESEARCH

BIOFUELS & ENVIRONMENTAL CATALYSIS

Development of Novel COS Adsorbents and Hydrolysis Catalysts for Clean Hydrogen Production

To facilitate the use of hydrocarbon fuels as feedstocks for hydrogen generation in fuel cell applications, the sulfur content of the feed must be reduced to sub-ppm levels. Sulfur is particularly problematic for Proton Exchange Membrane Fuel Cells (PEMFCs); at their low operating temperature (~80 °C), sulfur compounds adsorb strongly on the Pt electrocatalyst, blocking surface sites for hydrogen adsorption and dissociation. For natural gas and liquified petroleum gas (LPG), which are the feedstocks most suited for PEMFC applications (due to the highly developed infrastructure that exists for their distribution), ambient temperature removal of sulfur compounds using a solid adsorbent is technically attractive. Typical sulfur compounds include RSH, R_2S, H_2S and COS. COS is particularly problematic to remove as commercial sulfur adsorbents generally show poor adsorption capacities for COS at ambient temperature, and thermodynamic constraints limit COS removal via conventional hydrotreating.

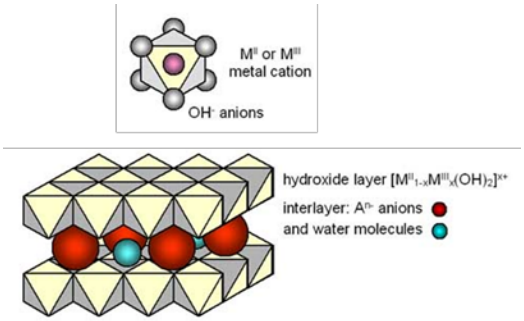

Figure 1: Schematic of LDH structure

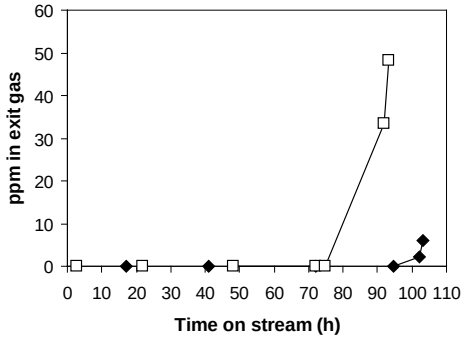

Figure 2. Breakthrough curves for COS (◆) and CH_3SH (□) adsorption on Ni/Mg/Al = 0.32/0.48/0.20 mixed oxide. Conditions: 293 K, 100 ppm COS or CH_3SH, N_2 as balance, GHSV = *ca.* 1800 h^{-1}.

We have found that mixed metal oxides, derived form the thermal decomposition of layered double hydroxides (LDHs, see Fig. 1), are promising ambient temperature adsorbents for COS. In general Ni/Mg/Al mixed oxides show the best performance, a composition with Ni/Mg/Al = 0.32/0.48/0.20 showing the highest adsorption capacity (corresponding to 2.5 wt.% COS; see Fig. 2). Treatment of the spent adsorbent under an atmosphere of 5% H_2 in N_2 at 723 K was found to provide an effective means of restoring the adsorption capacity over two cycles of adsorption and regeneration, although after three such cycles, adsorption capacity decreased. XPS data suggested the likely cause of this decrease to be a combination of sulfur accumulation at the surface and sintering of the Ni and Mg phases.

PARTICIPANTS

University of Kentucky
Center for Applied Energy Research
2540 Research Park Dr.
Lexington, KY 40511

SPONSORS

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CONTACT

Mark Crocker
UK CAER
2540 Research Park Dr.
Lexington, KY 40511
Tel.: (859) 257-0295
Fax: (859) 257-0220
crocker@caer.uky.edu