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Contamination of Complex Metal Hydrides with O_2, H_2O, and CO_2

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Safe and efficient hydrogen storage is a significant challenge inhibiting the use of hydrogen as a primary energy carrier. Although energy storage performance properties are critical to the success of solid-state hydrogen storage systems, operator and user safety is of highest importance when designing and implementing consumer products. As researchers are now integrating high energy density solid materials into hydrogen storage systems, quantification of the hazards associated with the operation and handling of these materials becomes imperative. The experimental effort presented in this paper focuses on identifying the hazards associated with producing, storing, and handling sodium alanates, and thus allowing for the development and implementation of hazard mitigation procedures. The chemical changes of sodium alanates associated with exposure to oxygen and water vapor have been characterized by thermal decomposition analysis using simultaneous thermogravimetric modulated beam mass spectrometry (STMBMS) and X-ray diffraction methods. Partial oxidation of sodium alanates, an alkali metal complex hydride, results in destabilization of the remaining hydrogen-containing material. At temperatures below 70°C, reaction of sodium alanate with water generates potentially combustible mixtures of H_2 and O_2. In addition to identifying the reaction hazards associated with the oxidation of alkali-metal containing complex hydrides, potential treatment methods are identified that chemically stabilize the oxidized material and reduce the hazard associated with handling the contaminated metal hydrides.