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Supporting Information

Using earth abundant materials for long duration energy storage: electro-chemical and thermo-chemical cycling of bicarbonate/formate

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Illustration of the thermocatalytic bicarbonate–formate transformation

A simple experiment was performed to illustrate the convenience and simplicity of using alkali bicarbonate (baking soda) to store and release hydrogen using a carbon-supported Pd catalyst. Baking soda, purchased from the grocery store was used in place of reagent-grade sodium bicarbonate. Tap water from the laboratory sink was used in place of laboratory de-ionized water. This simple experiment demonstrated that both hydrogenation and hydrogen release will occur at rates comparable to the rates observed using reactant grade solutions. **Fig. S1** shows the direct readings of pressure and volume changes. Figure 5 in the main text shows the corresponding changes in hydrogen amounts. The experiment consisted of subsequent hydrogenation and dehydrogenation. The experimental details are as follows.

A 49 mL Parr autoclave was charged with 3 wt.% Pd/C (83.3 mg) and a volume (10 mL) of sodium bicarbonate solution at a given concentration (1M). Then the sealed reactor was pressurized with 40 bar H_2 and heated to 25 °C for 5 h. After the reaction, the autoclave was cooled to room temperature and the excess pressure was released slowly. Then the subsequent dehydrogenation was performed after reheating the reaction mixture to 65 °C under isobaric conditions (1 atm). The evolved gas was passed through a NaOH trap to absorb the CO_2 and then through a flowmeter. The volume of the gas passed through the flowmeter was logged using the Labview software. After heating the reactor for a given time, the reactor was cooled to room temperature.

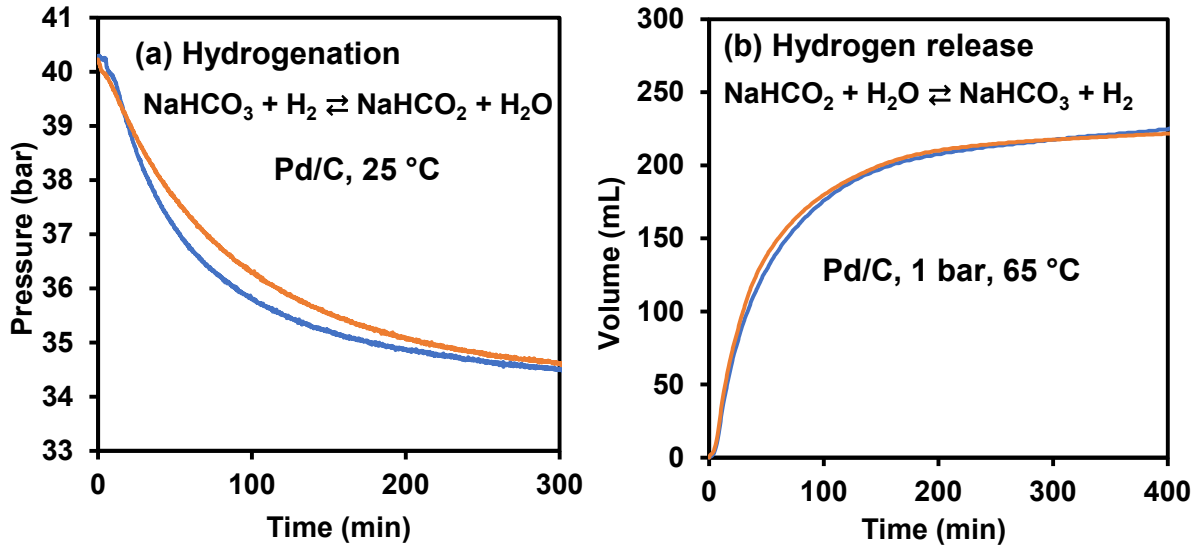

Figure S1. Thermochemical bicarbonate–formate cycle for hydrogen storage: (a) Blue line: reduction of 1M $NaHCO_3$ in ultra-pure water in the presence of commercial 3wt.% Pd/C; orange line: hydrogenation of baking soda in sea water in the presence of commercial 3wt.% Pd/C catalyst. (b) Blue line: oxidation of in situ formed sodium formate from 1M $NaHCO_3$ in ultra-pure water; orange line: oxidation of in situ formed sodium formate from baking soda in tap water. In both plots 100% represents the maximum amount of H_2 that the system can uptake or release.