Novel Chemical Mixtures for Hydrogen Generation by Combustion

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Hydrogen storage and generation systems are critical for lightweight, robust, cost effective fuel cell power sources. Hydrogen generation by combustion has the potential to significantly impact the fuel-cell industry. Portable fuel cells with replaceable hydrogen microgenerators could be used as chargers for various electronic devices, such as cell phones, laptop computers and PDAs, and also in aerospace and military applications.

To reach high hydrogen yield and combustion efficiency, we use novel sodium borohydride/aluminum/water mixtures, in which water acts as an oxidizer for both metal and sodium borohydride and simultaneously as a source of hydrogen, sodium borohydride is an additional hydrogen source, and aluminum enhances reaction exothermicity. Passivated aluminum nanoscale powders are used to ensure stability and high combustion efficiency. Along with the three reactants, the mixtures include a gelling agent and a stabilizer to prevent hydrolysis of borohydride at room temperature. Thermodynamic calculations for $NaBH_4/Al/H_2O$ system show significant increase in adiabatic combustion temperature with Al addition. Experiments with various $Al/NaBH_4$ mixture ratios and stoichiometric water content demonstrate that aluminum stimulates combustion, which is accompanied by significant hydrogen evolution (>6 wt.%). Estimates show that the proposed mixtures will yield ~50% more energy per unit weight than the best available fuel cell power supplies.