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Solving the problems of hydrogen energy

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Currently, metal hydrides are obtained mainly by the thermo-chemical method. In the thermo-chemical method, a process of hydrogenation is determined by setting of certain values of hydrogen's pressure and temperature, i.e.

$MeH_n \xleftarrow{P_1 T_1} \xrightarrow{P_2 T_2} Me + \frac{n}{2} H_2$, where Me is a metal or an alloy being under investigation and P1, T1 and P2, T2 are pressure and temperature of process of hydrogenation or dehydrogenation, respectively. In our works, the electrochemical method of obtaining metal hydrides was investigated. In this paper, it experimentally proved that during a Ni-Cd batteries long service life (more than five years), the hydrogen accumulation in large quantities takes place in a form of nickel hydrides in a sintered nickel matrix of oxide-nickel electrodes. The capacity of the sintered nickel matrix of the oxide-nickel electrode as a hydrogen absorber was quantified as 20.1 wt% and 400 kg m^{-3}. These values exceed thrice by all the earlier data obtained by traditional methods for any reversible metal hydride, including magnesium hydride or complex hydrides, also they far exceed the criteria for hydrogen storage systems established by the US Department of Energy. It is also proved that the thermal runaway can be used as a new high-performance method of desorption of hydrogen from metal-hydrides. On its kinetic and thermodynamic parameters, this method is considerably superior to requirements established by the US Department of Energy for onboard hydrogen storage systems. For its processing, the thermal runaway does not require any certain temperature or pressure. It can work at any temperature and pressure of ambiance. The hydrogen desorption by the method of the thermal runaway runs with aid of electrochemical reactions. This is why this process is easily controllable by electrotechnical methods and hence it is far less inertial than the thermal processes used in the traditional thermo-chemical method.

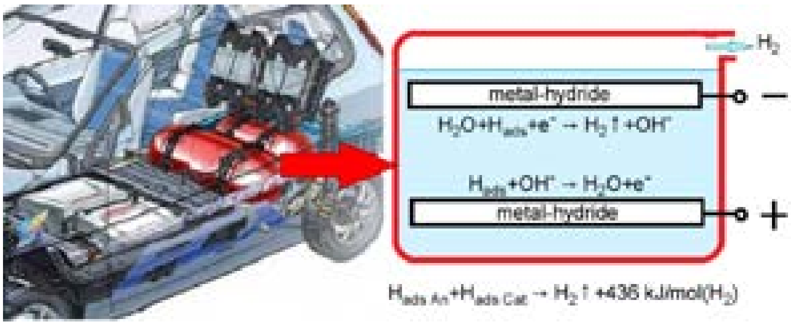

Figure 1: Thermal runaway as a new high-performance method of desorption of hydrogen from metal-hydrides.

Recent Publications:

1. Yazvinskaya N N, Galushkin N E and Galushkin D N (2018) Analytical model of thermal runaway in alkaline batteries. International Journal of Electrochemical Science 13:1275–1282.
2. Galushkin N E, Yazvinskaya N N and Galushkin D N (2018) Mechanism of thermal runaway in lithium-ion cells. Journal of the Electrochemical Society 165:A1303–A1308.
3. Galushkin N E, Yazvinskaya N N and Galushkin D N (2018) Electrochemical method of hydrogenation/dehydrogenation of metal hydrides, in book Hydrogen storage technologies. Wiley 5:150–166.
4. Galushkin N E, Yazvinskaya N N and Galushkin D N (2017) Pocket electrodes as hydrogen storage units of high-capacity. Journal of the Electrochemical Society 164:A2555–A2558.
5. Galushkin N E, Yazvinskaya N N and Galushkin D N (2016) Thermal runaway as a new high-performance method of desorption of hydrogen from hydrides. International Journal of Hydrogen Energy 41:14813–14819.

Biography

Nikolay E Galushkin is a professor at Don State Technical University, Russia. He heads the Electrochemical and Hydrogen Energy research laboratory at Don State Technical University, Russia. His research interests include: research and development of hydrogen storage systems meeting the criteria for on-board hydrogen storage systems that have been defined by the US Department of Energy; the study of the processes of thermal runaway in alkaline, acid and lithium-ion batteries; and the modeling of processes in electrochemical batteries to develop battery models suitable for practical use in electric vehicles.

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