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Poster Abstracts

P1

Hydrogen transport through nickel hydroxide electro-deposited films

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Hydrogen transport through electro-deposited nickel hydroxide films containing various fractions of cobalt hydroxide has been investigated by analysing build-up and decay current transients under the application of large (70 to 400 mV) and small (10 mV) voltage steps. The velocity and mobility of the phase boundary movement upon hydrogen extraction were determined to be in the order of 10^{-6} cm s^{-1} and 10^{-5} cm s^{-1} V^{-1} in magnitude, respectively. It is concluded that β-$Ni(OH)_2$ phase is stabilised by the $Co(OH)_2$ incorporation into the $Ni(OH)_2$ film and hence both the velocity and mobility of the $NiOOH/Ni(OH)_2$ phase boundary movement is raised by the $Co(OH)_2$ incorporation.

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P2

Accumulator batteries and operation of electric vehicles

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Accumulator batteries present a basic operational component of electric vehicles. Their functional characteristics affect significantly the utilization of electric vehicles in the city transport system mainly from the point of view of their driving range. The experience obtained during the operation of electric vehicles produced by SKODA Elcar Ltd., Ejpovice and ELIS Ltd., Plzen between 1992-1996 resulted in the fact that with regard to their purchase cost the lead-acid accumulator batteries and in a limited extent the nickel/cadmium batteries are most suitable for commercial application. The experience obtained with both lead-acid and nickel/cadmium batteries used in the operation of electric vehicles will be presented.

At present there are 40 electric vehicles operating in the Czech Republic. These have been produced by SKODA Elcar Ltd., Ejpovice and are the ELTRA 151L limousine and ELTRA 151 pick-up truck. Both types were gradually introduced into operation from 19th October 1992 until 3rd May 1994.

The users of these vehicles are energy, post, telecommunication, transport companies, ministries, police and wholesale organizations. The electric vehicles run in the capital city of Praha, in Brno, Plzefi, Ceské Budejovice, Pardubice, Pribram, Karlovy Vary, Podebrady, Kromerís, Raskovice and Karlstejn.

Four types of lead-acid accumulator batteries are used in these electric vehicles. Apart from 40 electric vehicles operating in Czech Republic, a further 110 examples of ELTRA 15IL and ELTRA 151 pick-up trucks were sold abroad. The construction of PROTOEL XI and PROTOEL 2 electric vehicles correspond to that of ELTRA 151 L and ELTRA 151 pick-up. The reconstruction of PROTOEL XI electric vehicles was carried out by the Institute for Research of Motor Vehicles, Praha and by the company TESLA Vrchlabí. The reconstruction of PROTOEL 2 was carried out by the above Institute. Nickel/cadmium batteries made by the French company SAFT have been used in both these electric vehicles.

P3

The calculated discharge curve

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In addition to the well-known discharge curve: $U_{d,i}$, / V versus t_i/time determined by kinetics, the corresponding sequence for the open-circuit voltage, $U_{o,i}$ / V was introduced from thermodynamics. Thermodynamically, this may be experimentally observed: (1) by continuously discharging "n" cells and interrupting the discharge at i-th steps (i = 1....*n*) or: (2) by periodically discharging one cell, measuring equilibrium potentials after long enough relaxation periods.

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During the relaxation period, because no current is flowing, only diffusion processes will be occurring. The internal resistance of a cell or battery was defined as: $R_{int,i} = (V_o - V_d)_i / I_i$ and the power from the internal resistance as: $P_{int,i} = (V_o - V_d)_i \times I_i$ where $I_i = V_{d,i}/R$ or I = constant and $I = 1...n$, $V_{o,o} > V_{d,i>} > V_{d,n} \geq V_{o,o}/2$.

Directly and integration by parts of internal energy losses lead to the differential equation: $dt/t = b.\ dP_{int}/P_{int}$, that is, time against power relationship.

Thermodynamically, the calculation was: (1) $V_{o,i} = (V_d + P_{int}/V_d)_i$, where $P_{int,i} = (t_i/a_i)^{\wedge 1/bi}$. Using experimentally observed kinetics and the known discharge curve: ($V_{d,i}$ versus t_i, where i = 1...n) and (2), $dP_{int} = d\{(V_o - V_d).\ I\}$, a time-independent differential equation is obtained, which can be integrated as a Clairaut's one.

By short-term discharging, that is: $V_{o,o} > V_{d,i>} > V_{d,k}$, $i = 1...k$, $k \ll n$, $V_{d,n} \geq V_o/2$ and $\phi < t_i < t_k \ll t_n$, and measuring $V_{o,o}$ and $V_{o,k}$ by using time-dependent thermodynamic calculations ($V_{o,i}$ versus $V_{d,i}$) and $dt/t = b.dP_{int}/P_{int}$ the calculated discharge curve: $V_{d,i}$ versus t_i, $i = 1...n$, $V_o > V_{d,i} > V_{o,n} \gg V_o/2$ was obtained. The short-time interval, i = 1...k, must be divided into: (1) initial conditions: $V_{o,o}$, $V_{d,1}$, $V_{d,2}$ versus ϕ, t_1, t_2, respectively and (2) the control subinterval: $V_{d,.3....k}$ versus $t_{3.....k}$ and $V_{o,k}$ measured after a relaxation period. Measured $V_{o,o}$ and $V_{o,k}$ and estimated $V_{o,1}$ values define the $V_{o,n}$.

The above equations were verified by experiment and published discharge data on primary and secondary cells and batteries, ranging in size from small to stationary designs as large as 1000 Ah, with voltage strings as high as 380 V.

By the calculated discharge curve, using known thermodynamic and kinetic data, a primary or secondary cell or battery may be investigated as an electrochemical system.

P4

New achievements in the cycle life of the silver/zinc battery

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Shape-change and dendritic growth are the main drawbacks limiting the cycle life of the silver/zinc battery. These problems can be overcome by insertion of thin high-porous nickel membranes between the electrodes of the battery. In this poster are presented experimental data on the performance of silver/zinc batteries containing these membranes and results of cycling tests. The results reveal a substantial increase of the cycle life of the silver/zinc battery without any significant effect of the membranes on its performance.

P5

Development of cell components for a 20 Ah, 12 V secondary zinc/air battery

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Electrically rechargeable zinc/air-batteries are being considered for both electric vehicle and portable device applications. The high theoretical (1150 Wh kg^{-1}) as well as practical specific energy (60–150 Wh kg^{-1}) are major advantages of the secondary zinc/oxygen battery. The low cost and low toxicity of the materials involved are also an important factor.

By developing a durable perovskite-catalyzed bifunctional oxygen electrode and a long-lived pasted zinc electrode, the cycle life behaviour of secondary zinc/oxygen cells has been improved considerably [1].

The tested monopolar cells consisted of one pasted zinc electrode, having a nominal capacity of 2.5 Ah and an electrode size of 25 cm^2 sandwiched between two bifunctional oxygen electrodes.

In this poster we will present the scale-up of the manufacturing method for the pasted zinc electrodes as well as for the bifunctional oxygen electrodes. The electrode size was increased from 25 to 150–200 cm^2. Moreover, results obtained with larger zinc/oxygen batteries having a monopolar electrode arrangement will be presented. Cycle life, discharge capacity, specific power and specific energy data of the tested batteries will be shown in relation to the results obtained with single (2.5 Ah) cells.

References

[1] S. Müller, F. Holzer, C. Schlatter, C. Comninellis and O. Haas, *Proc. of the Rechargeable Zinc Batteries Symposium, 188th Meeting of the Electrochem. Soc., Chicago, Oct. 1995.*

P6

Glassy carbon capacitor stack

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To meet the peak power demands in electric or hybrid vehicles, great efforts are being made to develop high power density, high energy density capacitors, such as electrochemical double-layer capacitors (EDC). The energy storage arises from the double-layer formed at the interface between electrolyte and electrode. Low internal resistance of the capacitor is required to reach high power.