ACTIVATION SYSTEM FOR ELECTROCHEMICAL AUTOMOTIVE POWER DEVICES

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ABSTRACT

Batteries and fuel cells are electrochemical devices currently further developed to meet the increasing power demands for Auxiliary Power Systems in combustion engine cars as well as to enable future hybrid engine cars and electrical car technology.

Because the kinetic of electrochemical reactions is strongly dependent upon temperature, a reliable operation of batteries and fuel cells requires stable temperature conditions. Furthermore, high efficiency of electrochemical energy conversion usually can be achieved only in a certain temperature interval, therefore temperature management independently of operation conditions is very important for stable and efficient operation of batteries and fuel cells.

Using a specially designed microwave source [1,2], active temperature control of the Gas Diffusion Electrodes and catalyst layers in hydrogen and direct methanol polymer fuel cells, H_2-PEM and DMFC is enabled. In such fuel cells, depending upon the catalytic reaction of the fuel at the anode and the oxygen at the cathode, the conversion efficiency of chemical energy into electrical power may vary, causing secondary effects, like e.g., water deficiency at selected positions of the membrane or poisoning of the catalyst in case of methanol or hydrocarbon conversion at temperatures below 100 °C. Irreversible damage of the materials used can occur, e.g., the ionomer membranes can rupture due to increased brittleness of the dry membrane or the catalyst can loose activity due to CO-poisoning.

The microwave device makes use of the different absorption ability of materials currently applied in PEM-stacks for microwave radiation. Due to the electronic conductivity, selective heating of carbon materials and finely divided metals (Pt and other catalyst) by microwave absorption is possible, with high heating rates using short pulses of microwave energy. The membrane materials are not affected although heating rates of 100 K/s can be achieved at small metal particles as well as for certain portions of the carbon materials. De-sorption of CO as well as a fast preheating of the GDE to improve the catalytic activity independently of the operation conditions and external heat sources are possible using such an activation system.

The paper will present calculations and experimental results of the microwave activation of a GDL using the fuel cell gas distribution system of the bipolar plate as a waveguide structure, called a “Current Collector Antenna”, CCA, and to transfer microwave radiation into the relevant regions of the fuel cell stack. No additional weight or volume is needed within a fuel cell stack. The power requirements of the microwave source can be matched by microwave diodes known from mobile phone technology or by cheap magnetrons. Conventional electronic devices can be used to operate a microwave pulsing sequence. Besides fuel cells, such a system is also applicable to batteries.

REFERENCES

[1] Patent application DE 142 076 99

[2] Presented at „Innovationspreis Brennstoffzelle, September 29, 2003, Stuttgart, Germany