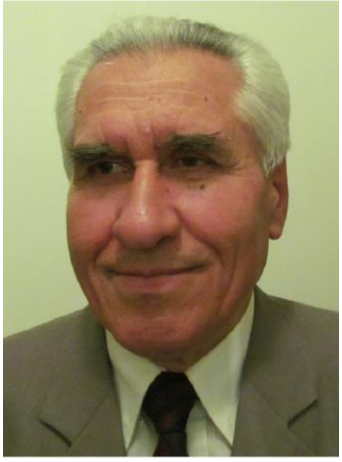
TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG

Die Ressourcenuniversität. Seit 1765.

Montag, 3. Juni 2013 | Monday, 3rd June 2013
17:00 – 17:45 Uhr



Supercapacitor specialities – Materials Review

Vasile V. N. Obreja

National Research and Development Institute for Microtechnology (IMT-Bucharest), Bucharest, 077190, Romania

Abstract. The electrode material is a key component for a supercapacitor cell performance. As it is known, performance comparison of commercial available batteries and supercapacitors reveals significantly lower energy storage capability for supercapacitor devices. The energy density of commercial supercapacitor cells is limited to 10 Wh/kg whereas that of common lead acid batteries reaches 30 - 35 Wh/kg. For lithium ion batteries a value higher than 100 Wh/kg is easily available. Nevertheless, supercapacitors also known as ultracapacitors or electrochemical capacitors have other advantages in comparison with batteries. As a consequence, many efforts have been made in the last years to increase the storage energy density of electrochemical capacitors. A lot of results from published work (research and review papers, patents and reports) are available at this time. The purpose of this review is a presentation of the progress to date for the use of new materials and approaches for electrode materials, with focus on the energy storage capability for practical applications.

Many reported results refer to nanostructured carbon based materials and the related composites, used for the manufacture of experimental electrodes. A specific capacitance and a specific energy is seldom revealed as the main result of the performed investigation. Thus for nanoprous (activated) carbon based electrodes a specific capacitance up to 200 - 240 F/g is mentioned for organic electrolyte, whereas for aqueous electrolyte, the value is limited to 400 - 500 F/g. By taking into account the value of the specific capacitance, specific energy values in a range of 10 - 50 Wh/kg (depending of the electrolyte type and electrochemical cell) have been reported. Nonetheless such values are given only for one electrode and for the carbon material used in the electrode.

For a supercapacitor cell, where two electrodes and also other materials for cell assembling and packaging are used, the above mentioned values have to be divided by a factor higher than two. As a consequence, for activated carbon which is an affordable material as cost, specific energy higher than 10 Wh/kg cannot be reached with the existing manufacturing technology. Carbon nanotubes, graphene material derivatives and related composites have been used in many experiments reported in the last years. Nevertheless in spite of the outstanding properties of these materials, significant increase of the specific capacitance or of the specific energy in comparison with activated carbon is not achieved.

Further advance in the electrode manufacture is required for higher performance of carbon based electrodes. Use of "pseudocapacitive" materials like metal oxides or conducting polymers in combination with different nanostructured carbon materials (nanocomposite electrodes) has been found to contribute to further increase of the specific capacitance or of the specific energy.

Nevertheless, few results are reported for practical cells with such materials. Many results are reported only for a three electrode system (working investigated material electrode, counter electrode and reference electrode) and significant difference is possible when the electrode is used in a practical supercapacitor cell. Such drawback has been outlined in a reference paper.

Further improvement in the electrode manufacture and more experiments with supercapacitor cells with the known electrochemical storage materials are required. Device prototypes and commercial products with an energy density towards 15 - 20 Wh/kg. could be realized. These may be a milestone for further product research and development to narrow the storage energy gap between batteries and supercapacitors.