Nanocoral ZnO-based Transparent Supercapacitor

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The research on transparent supercapacitors is at the moment mostly restricted to constructions making use of the well-studied nanostructured carbon electrodes that were fabricated thin enough so that they can exhibit a limited transparency [1,2]. Recenlty, we developed a novel approach where the transparent electrodes are realized by the application of a nanostructured wide band-gap material.

This report presents the preliminary results of material studies and construction tests of a supercapacitor based on nanocoral ZnO for applications in transparent electronics. Nanocoral ZnO is fabricated using room temperature magnetron sputtering of porous Zn with a 30 s post deposition oxidation in an RTP furnace at 400°C [3]. The maximum thickness of the fabricated ZnO allowing 90% transmission in the visible light is determined by optical transmission measurements and the morphological development of the nanostructured film as a function of its thickness is studied by means of scanning electron microscopy (SEM). The transport properties of a porous medium cannot be determined through a Hall effect measurements, therefore we measured resistances of films with set dimensions. Controlled doping of the material was realized by the introduction of the H shallow donor through RTP annealing processes in an argon-hydrogen gas mixture at temperatures ranging from 300°C to 500°C. The resistance of the nanostructures was measured after treatment. SEM imaging and X-ray diffraction measurements were applied to study the thermal stability of the material morphology and structure related to the high temperature doping process.

The construction of a supercapacitor was based on two nanocoral ZnO electrodes. A LiCl/poly(vinyl alcohol)-based gel electrolyte was sandwiched between two such electrodes. The device characteristics were measured using a potentiostat. The devices were tested using cyclic voltammetry in 0-1 V range with 20-100 mV/s sweeps. The obtained results are highly promising due to the registered I-V characteristic nonlinearities indicating potential for high capacitance. Uniform 20 $\mu F/cm^2$ capacitance in the whole bias range and 94% capacitance retention during 1600 charging/discharging cycles confirm the high application potential of ZnO in supercapacitors and form a good basis for further research.

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