

Metal Tetraaminophthalocyanine Polymers as Organic Supercapacitor Materials

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Recently, the cost and environmental impact of fossil fuel usage has led to a desire to develop better means of electrical energy storage, especially for hybrid and electric vehicles and in green energy applications. One solution is to pair the fast charge/discharge capability and high power density of supercapacitors with the high energy density of batteries. In this work, n-doped conductive polymers are investigated as novel supercapacitor electrodes. These polymers were formed through oxidative electrochemical polymerization of metal tetraaminophthalocyanines (TAPCs) (see Figure 1). These films were then characterized by cyclic voltammetry (CV), chronopotentiometry, and chronoamperometry.

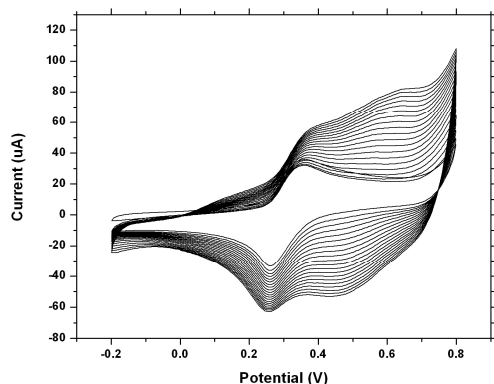


Figure 1. Typical CV polymerization of NiT4APc in DMF/0.5 M NaClO₄ solution, using a glassy carbon electrode (GCE) and silver wire reference at 100 mV/s.

Of the three metals tested (Cu, Co, and Ni), NiTAPc displayed the highest capacitance and electronic conductivity. As seen in Figure 2, this conductivity is maintained over a large window at negative potentials, a property that is not seen in other common conductive organic polymers like polyaniline or polypyrrole.

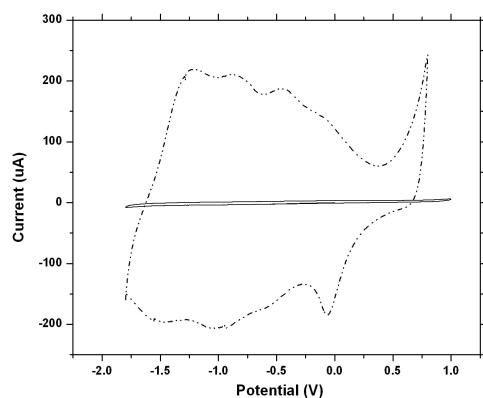


Figure 2. CVs obtained in DMF/0.5 M NaClO₄ (100 mV/s) at a bare GCE (solid trace) and at a poly-NiT4APc-coated GCE (dashed trace). The coated electrode was prepared as in Figure 1 (40 cycles).

By increasing the polymerization time of NiTAPc, relatively thick films (several microns) could be formed, with estimated specific capacitance values in excess of 600 F g⁻¹. Scanning electron microscopy provides some insight, showing that the films exhibit porous microstructures containing submicron features. The morphology of the films was found to vary with polymerization conditions, including choice of solvent, potential limits, monomer concentration, and coating thickness. Capacitance measurements, electrochemical behavior, morphological studies, and cycling stability of these films will be discussed in detail.