

## Characteristics of Tantalum Capacitors with Electrochemically prepared Polypyrrole

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Tantalum Capacitors with electronically conductive polypyrrole as a solid electrolyte were prepared and characterized. The effects of concentrations of pyrrole as a monomer, tetraethylammonium p-toluenesulfonate as a dopant, and oxalic acid as a catalyst in organic solvent were investigated. Tantalum powder (H. G. Starck) of 30,000 CV/g was used to form 4×3×2 mm element which was sintered under 1700°C and 10<sup>-5</sup> torr. A dielectric film of Ta<sub>2</sub>O<sub>5</sub> was made by anodic oxidation in the 1% phosphoric acid solution at 50°C. The constant current applied until the element voltage reached to 30 V. The base conductive layer of polypyrrole was produced by chemical polymerization in ammonium peroxodisulfate (0.2M) and pyrrole (2M) solutions. During electrochemical polymerization, the constant current of 0.5 mA applied for 5 hours at various concentrations of pyrrole, tetraethylammonium p-toluenesulfonate, and oxalic acid (0.1~1.0M). While the ionic conductivity of electrolyte varied with the concentration of tetraethylammonium p-toluenesulfonate, pH of electrolyte varied with the concentration of oxalic acid. The surface conductivity of polypyrrole film prepared with electrochemical polymerization was extremely improved with oxalic acid. Surface and section SEM showed that increasing the concentration of pyrrole, tetraethylammonium p-toluenesulfonate, or oxalic acid resulted uniform cabbage flower form. While the concentration of pyrrole dominated the capacitance of tantalum capacitor, the concentration of oxalic acid dominated the ESR of tantalum capacitor. In addition, the concentration of tetraethylammonium p-toluenesulfonate and oxalic acid dominated the dissipation factor. Especially, the conductivity and dissipation factor of tantalum capacitor improved significantly by addition of oxalic acid (above 0.2M). As conclusion, electrochemically prepared polypyrrole at 0.5M of pyrrole, 0.3M of tetraethylammonium p-toluenesulfonate, and 0.2M of oxalic acid resulted Ta capacitor with 43 mohm (compared to 100 mohm of conventional Ta/MnO<sub>2</sub> capacitor).

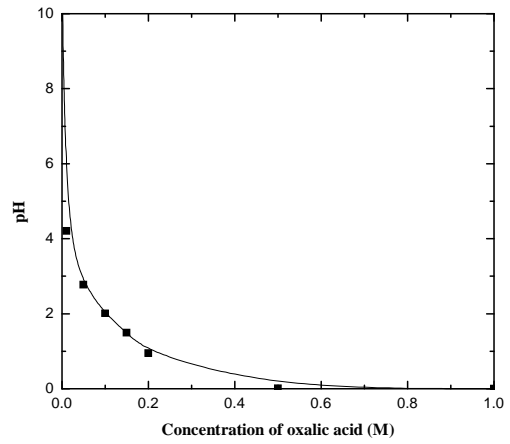


Fig. 1. The effects of concentration of oxalic acid on the pH of electrolyte.

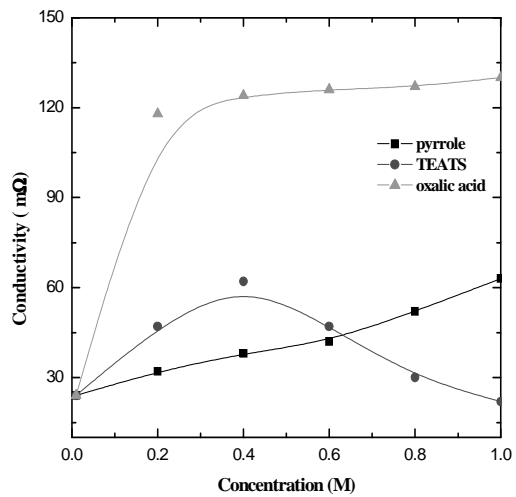


Fig. 2. The effects of concentrations at electrochemical polymerization on the conductivity of polypyrrole film

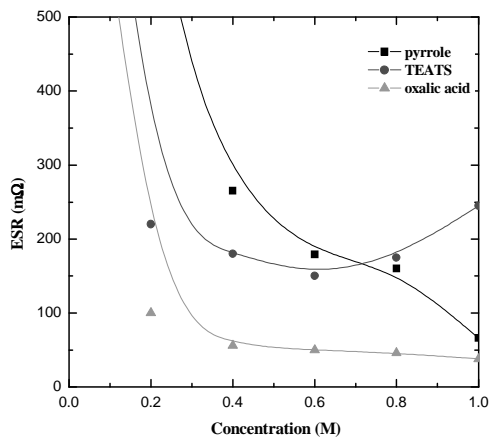


Fig. 3. The effects of the concentrations at electrochemical polymerization on the ESR of Ta/Ppy capacitor