Sintesis dan aplikasi TiO2 nanotube sebagai kapasitor dan pendukung kapasitor TiO2- RuO2 = Synthesis and application of TiO2 nanotube as capacitor and Co-Capacitor TiO2-RuO2

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Abstrak

[ABSTRAK
Kapasitor elektrokimia merupakan piranti yang dapat menyimpan energi listrik pada kedua sisi elektrodanya. Pada penelitian ini elektroda kapasitor elektrokimia dibuat dari TiO2 Nanotube (TiO2-NT) dan komposit TiO2-RuO2. TiO2-NT disintesis dengan metode anodisasi logam Ti menggunakan elektrolit NH4F dalam gliserol dan air sedangkan komposit TiO2-RuO2 didapatkan dengan mengendapkan RuO2 pada TiO2-NT melalui metode elektrodeposisi. TiO2-NT dikalsinasi pada suhu 300oC, 400oC dan 500oC, dan dilakukan pengamatan pengaruh perubahan suhu kalsinasi terhadap morfologi, fasa kristal dan besar nilai kapasitansi titania. TiO2-NT dengan kondisi optimum dan nilai kapasitansi tertinggi dibentuk menjadi komposit dengan RuO2. Karakterisasi dilakukan dengan peralatan SEM, XRD, FTIR, dan UV-VIS DRS, sedangkan sifat elektrokimia dan unjuk kerja elektroda diuji dengan metode linier sweep voltametry (LSV), voltametri siklik dan pengisian-pengosongan galvanostatik (PPG). Hasil karakterisasi menunjukkan bahwa kalsinasi tidak mengubah morfologi nanotube, tetapi mempengaruhi ukuran diameter dan ketebalan dinding tube TiO2, ukuran diameter yang relatif seragam, yaitu 50,15 ± 1,30 nm diperoleh pada suhu kalsinasi 400oC. Analisa difraktogram menunjukkan bahwa TiO2-NT hasil sintesis berbentuk amorf, sedangkan kalsinasi pada suhu 400oC dan 500oC menghasilkan kristal anatase TiO2 dengan nilai band gap 3,2eV. TiO2-NT diketahui bersifat aktif dengan menunjukkan respon arus cahaya saat dikenai sinar UV dengan nilai yang meningkat seiring kenaikan suhu kalsinasi. Karakterisasi komposit TiO2-RuO2 menunjukkan kandungan Ru yang relatif kecil (4,8%) dibandingkan massa Ti. RuO2 yang terdeposit berbentuk amorf dan mengandung air. Nilai kapasitansi elektroda kapasitor TiO2-NT dan TiO2-RuO2 dengan metode voltametri siklik didapatkan masing-masing 565,09F/cm2 dan 979,5F/cm2, sedangkan nilai kapasitansi dengan uji PPG pada TiO2-NT didapatkan kapasitansi 31,86 F/cm2 dan TiO2-RuO2 580,36 F/cm2. Nilai kapasitansi menunjukkan bahwa TiO2-NT dapat digunakan sebagai elektroda kapasitor dan pendukung elektroda kapasitor dalam bentuk komposit TiO2-RuO2.
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ABSTRACT
Electrochemical capacitors are energy storage devices which store electrical energy in two series electrodes. In this work, the capacitor electrodes made of TiO2 nanotube and TiO2-RuO2 composite. TiO2-NT were synthesized by anodization method in NH4F electrolyte with glycerol and water. The composite electrode were obtained by electrodeposition of RuO2 from RuCl3 solution on TiO2-NT which has optimum condition and high capacitances. The anodized TiO2-NT was calcined in a range of temperatures between 300oC to 500oC and the influences of temperature to morphology, crystal phase and capacitance values of TiO2-NT were observed. The characterizations were performed by SEM, XRD, FTIR and UV-VIS DRS instruments and the electrochemical behaviour and the electrode performance were conducted with linier sweep voltametry, cyclic voltametry and galvanostatics charge-discharge test. The temperature calcinations

didnot change the morphology of TiO2-NT, but influence diameter size and tubes thickness, in which the uniform diameter 50,15 ± 1,30 nm was obtained from 400oC of TiO2-NT. The as anodized TiO2-NT were in amorphous phase, on the other hand, 400oC and 500oC of TiO2-NT were anatase crystal structure with 3.2eV band gap. TiO2-NT showed photocurrent responses with UV light and the values rised as the temperature increased. SEM-EDX showed the composite composition, Ru have smaller mass percentage (4,8%) than Ti. The phase of RuO2 was amorphous and contained water molecules or in hidrates form. TiO2-NT prepared at 400oC yielded the largest capacitances of 565,09F/cm2 and TiO2-RuO2 composites of 979,5F/cm2 at a scan rate of 10 mVs-1. GCD test, give the capacitance 31,86 F/cm2 of TiO2-NT and 580,36 F/cm2 of TiO2-RuO2 composites. These findings of capacitance could open new opportunities of TiO2-NT materials in constructing high performance capacitors and supporting capacitors in the form of TiO2-RuO2 composite;Electrochemical capacitors are energy storage devices which store electrical energy in two series electrodes. In this work, the capacitor electrodes made of TiO2 nanotube and TiO2-RuO2 composite. TiO2-NT were synthesized by anodization method in NH4F electrolyte with glycerol and water. The composite electrode were obtained by electrodeposition of RuO2 from RuCl3 solution on TiO2-NT which has optimum condition and high capacitances. The anodized TiO2-NT was calcined in a range of temperatures between 300oC to 500oC and the influences of temperature to morphology, crystal phase and capacitance values of TiO2-NT were observed. The characterizations were performed by SEM, XRD, FTIR and UV-VIS DRS instruments and the electrochemical behaviour and the electrode performance were conducted with linier sweep voltametry, cyclic voltametry and galvanostatics charge-discharge test. The temperature calcinations didnot change the morphology of TiO2-NT, but influence diameter size and tubes thickness, in which the uniform diameter 50,15 ± 1,30 nm was obtained from 400oC of TiO2-NT. The as anodized TiO2-NT were in amorphous phase, on the other hand, 400oC and 500oC of TiO2-NT were anatase crystal structure with 3.2eV band gap. TiO2-NT showed photocurrent responses with UV light and the values rised as the temperature increased. SEM-EDX showed the composite composition, Ru have smaller mass percentage (4,8%) than Ti. The phase of RuO2 was amorphous and contained water molecules or in hidrates form. TiO2-NT prepared at 400oC yielded the largest capacitances of 565,09F/cm2 and TiO2-RuO2 composites of 979,5F/cm2 at a scan rate of 10 mVs-1. GCD test, give the capacitance 31,86 F/cm2 of TiO2-NT and 580,36 F/cm2 of TiO2-RuO2 composites. These findings of capacitance could open new opportunities of TiO2-NT materials in constructing high performance capacitors and supporting capacitors in the form of TiO2-RuO2 composite, Electrochemical capacitors are energy storage devices which store electrical energy in two series electrodes. In this work, the capacitor electrodes made of TiO2 nanotube and TiO2-RuO2 composite. TiO2-NT were synthesized by anodization method in NH4F electrolyte with glycerol and water. The composite electrode were obtained by electrodeposition of RuO2 from RuCl3 solution on TiO2-NT which has optimum condition and high capacitances. The anodized TiO2-NT was calcined in a range of temperatures between 300oC to 500oC and the influences of temperature to morphology, crystal phase and capacitance values of TiO2-NT were observed. The characterizations were performed by SEM, XRD, FTIR and UV-VIS DRS instruments and the electrochemical behaviour and the electrode performance were conducted with linier sweep voltametry, cyclic voltametry and galvanostatics charge-discharge test. The temperature calcinations didnot change the morphology of TiO2-NT, but influence diameter size and tubes thickness, in which the uniform diameter 50,15 ± 1,30 nm was obtained from 400oC of TiO2-NT. The as anodized TiO2-NT were in amorphous phase, on the other hand, 400oC and 500oC of TiO2-NT were anatase crystal structure with 3.2eV band gap. TiO2-NT showed photocurrent

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