Sintesis dan karakterisasi material katoda LiMn0.7Fe0.3-xNixPO4/C dengan 0X0.2 dalam aplikasi baterai Li-Ion = Synthesis and characterization of cathode material LiMn0.7Fe0.3-xNixPO4/C with 0X0.2 in application of Li-Ion battery

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Abstrak

Struktur Olivine LiMnPO4 sebagai material katoda baterai Li-ion memiliki daya tarik tersendiri dikarenakan nilai potensial oksidasi-reduksi yang tinggi yaitu 4.2 volt terhadap Li/Li+, stabil secara termal, dan relatif ramah lingkungan (nontoxic).
Namun nilai konduktifitas ionik dan elektronik yang rendah sekitar (10-9 S/cm), nilai specific capacity yang rendah akibat distorsi kisi (Jahn-Teller effect),
menjadi tantangan tersendiri. Proses pelapisan karbon pada bahan aktif LiMnPO4 dengan menggunakan starch atau pati singkong , subtitusi kation dengan penambahan Fe dan Ni (covalent-doping) dimana formulasi LiMn0.7Fe0.3-
xNixPO4/C dengan 0 X 0.2 digunakan untuk meningkatkan konduktifitas elektronik-ionik, nilai specific capacity dan working voltage (Voksidasi/reduksi).
Pengujian XRD menunjukan pola difraksi struktur kristal LiMnPO4 telah berhasil terbentuk melalui proses milling (330 rpm, 48 jam) dan sintering disuhu 800°C (solid state reaction). Proses reduksi ukuran dan coating karbon dengan Ball Milling mampu menghasilkan partikel bahan aktif LiMn0.7Fe0.3-xNixPO4/C dengan 0 X 0.2 berukuran hingga 290 nanometer dengan ukuran kristalit hingga 60 nanometer.
Pertumbuhan pelapisan karbon kearah horizontal pada bahan aktif LiMn0.7Fe0.3-xNixPO4/C dengan 0 X 0.2 menjadi bukti bahwa starch atau pati singkong berperan sebagai fasilitator pengintian pelapisan karbon dan terlihat pada pengujian SEM (perbesaran 50000 x) dan pengujian EDX dengan kadar Mn
yang tinggi menjadi bukti penguat. Frame network polianion terbentuk pada bahan aktif LiMn0.7Fe0.3-xNixPO4/C dengan 0 X 0.2 ditandai dengan nilai vibrasi v1- v4 (1138 dan 1098 cm-1) yang dominan muncul pada hasil pengujian FTIR. Penambahan karbon sebagai pelapis bahan aktif memberikan nilai konduktifitas elektronik (pasif) dan ionik (aktif) yang cukup tinggi sekitar 1 x 10-3 S/cm dan 7.2 S/cm, dimana penambahan Ni (doping kation) berkontribusi dalam peningkatan nilai konduktifitas elektronik (pasif). Komposisi bahan aktif
LiMn0.7Fe0.25Ni0.05PO4/C menunjukan nilai specific capacity oksidasi hingga 60.92 mAh/gr dan nilai Voksidasi-reduksi sekitar 4.13 volt dan mampu digunakan
sebagai bahan aktif katoda baterai Li-ion secara praktikal dari hasil pengujian cyclic voltammetry. Puncak Voksidasi/reduksi ganda yang merupakan kontribusi
Voksidasi Fe2+/Fe3+ dan Mn2+/Mn3+ sering terlihat pada hasil pengujian cyclic voltammetry.
......Olivine LiMnPO4 structure as cathode material in Li-ion battery have very
attractive because its high potential oxidation/reduction around 4.2 volts vs. Li/Li+,
thermally stable, and nontoxic. Its low electronic and ionic conductivity around
(10-9 S/cm), low specific capacity by lattice distortion (Jahn-Teller effect),
become its challenges. Carbon-coating process with starch of cassava in cathode

material LiMnPO4, co-subtitution by adding Fe and Ni where LiMn0.7Fe0.3-xNixPO4/C with 0   X   0.2 formulation have been used to enhanced ionicelectronic conductivity, specific capacity, and working voltage of cathode material.
Pattern diffraction of XRD shown LiMnPO4 structure have been formed via milling process (330 rpm, 48 hours) and sintering process at 800°C (solid state reaction). Size reduction process and carbon coating have been carried and produced cathode material LiMn0.7Fe0.3-xNixPO4/C with 0   X   0.2 with the particle size up to 290 nanometers and crystallite size up to 60 nanometers. Carbon-coating process have been grown in horizontal direction in cathode material LiMn0.7Fe0.3-xNixPO4/C with 0   X   0.2 and become approval that the starch of cassava have been facilitates nuklea of carbon-coating to grown in cathode material and can be seen by SEM with magnification 50000 times, and also the high content of Mn that have founded by EDX evaluation agreed. Frame network of polyanion have formed in cathode material LiMn0.7Fe0.3-xNixPO4/C with 0   X   0.2 indicated by vibration value of v1- v4 (1138 and 1098 cm-1) that appeared dominantly during FTIR evaluation. Electronic conductivity (passive) of cathode material LiMn0.7Fe0.3-xNixPO4/C with 0   X   0.2 increased significantly up to 1 x 10-3 S/cm by carbon-adding process as carbon-coating in cathode material, where the process of Ni-added as cation-doping also contribute in increasing the value of electronic conductivity. Based of cyclic voltammetry evaluation the formulation LiMn0.7Fe0.25Ni0.05PO4/C of cathode material shown the highest specific capacity oxidation near 60.92 mAh/gr and Voxidation/reduction around 4.13 volts and practically can be used as Li-ion battery. Doblet Voxidation/reduction peak appeared several times as the contribution of Voxidation/reduction Fe2+/Fe3+ and Mn2+/Mn3+ in cyclic voltammetry evaluation.