

Sintesis serbuk $\text{Li}_4\text{Ti}_5\text{O}_{12}$ yang didoping atom Al dan Na untuk material anoda pada baterai ion lithium = Synthesis of $\text{Li}_4\text{Ti}_5\text{O}_{12}$ powder doped by al and na atoms for lithium ion battery anodes

Slamet Priyono, author

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Abstrak

[ABSTRAK

Sintesis serbuk $\text{Li}_4\text{Ti}_5\text{O}_{12}$ yang didoping atom Al dan Na untuk material anoda pada baterai ion lithium telah berhasil dilakukan dengan metode reaksi padat. Doping Al pada $\text{Li}_4\text{Ti}_5\text{O}_{12}$ bertujuan untuk menaikkan konduktifitas ionik dan memperkuat struktur sedangkan doping Na bertujuan untuk menurunkan tegangan operasi. Pendopingan dilakukan dengan mengikuti persamaan $\text{Li}_{(4-(x/3+y))}\text{Al}_x\text{Na}_y\text{Ti}_{(5-2x/3)}\text{O}_{12}$ ($x=0; 0,025; 0,05; 0,075$ dan $y=0;1$) dimana atom Al mensubstitusi Ti dan Li sedangkan atom Na mensubstitusi Li. Sintesis dilakukan melalui metoda metalurgi serbuk dengan menggunakan Li_2CO_3 , TiO_2 -anatase, Al_2O_3 and Na_2CO_3 sebagai bahan baku. Pada penelitian ini, pengaruh substitusi Na dan Al dalam $\text{Li}_4\text{Ti}_5\text{O}_{12}$ terhadap struktur, morfologi, ukuran partikel, surface area dan performa elektrokimia diteliti secara detil. Hasil penelitian menunjukkan bahwa doping ion Al pada $\text{Li}_4\text{Ti}_5\text{O}_{12}$ tidak merubah struktur kristal $\text{Li}_4\text{Ti}_5\text{O}_{12}$. Hasil FTIR menkonfirmasi tidak adanya perubahan struktur spinel pada gugus khas ketika didoping Al, dengan meningkatnya doping Al membuat tekstur butir menjadi berpori, ukuran partikel menurun dengan ukuran terkecil 20,32 m, surface area meningkat dengan nilai tertinggi 8,25 m^2/gr , konduktifitas ionik meningkat dengan konduktifitas terbaik adalah $8,5 \times 10^{-5}$ S/cm, tegangan kerja sekitar 1,55 V dan kestabilan siklus terbaik diperoleh pada doping Al 0,025 dengan kapasitas maksimum 70 mAh/g,. Sedangkan doping Na dalam $\text{Li}_4\text{Ti}_5\text{O}_{12}$ menyebabkan perubahan struktur dengan terbentuk 3 fasa baru yaitu $\text{NaLiTi}_3\text{O}_7$, $\text{Li}_4\text{Ti}_5\text{O}_{12}$, dan Li_2TiO_3 . Perubahan struktur juga dikonfirmasi dengan perubahan gugus khas hasil analysis FTIR. Sedangkan kenaikan doping Al menyebabkan fasa $\text{NaLiTi}_3\text{O}_7$ semakin dominan, tekstur butiran menjadi halus, ukuran partikel menurun dengan ukuran terkecil 30,89 m, surface area menurun, konduktifitas ionik stabil pada $2,5 \times 10^{-5}$ S/cm, potensial kerja di 1,3 V dan 1,55V, kestabilan struktur didapat pada doping Al 0,05 dengan kapasitas 90 mAh/g. Secara keseluruhan menunjukkan bahwa penambahan doping Al mampu meningkatkan konduktifitas ionik dan kestabilan siklus dan doping Na menurunkan tegangan kerja.

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ABSTRACT

Synthesis of $\text{Li}_4\text{Ti}_5\text{O}_{12}$ powder doped by Al and Na atoms for lithium ion battery anodes had been carried out using solid state reaction. Al doped on $\text{Li}_4\text{Ti}_5\text{O}_{12}$ aim

is to increase the ionic conductivity and strengthen the structure of $\text{Li}_4\text{Ti}_5\text{O}_{12}$ while Na doped aimed is to decrease the operating voltage. Al and Na doped on $\text{Li}_4\text{Ti}_5\text{O}_{12}$ had been carried out by following equation $\text{Li}(4 - (x / 3 + y))\text{Al}_x\text{Na}_y\text{Ti}(5 - 2x/3)\text{O}_{12}$ ($x = 0; 0,025; 0.05, 0.075$ and $y = 0, 1$) where the Al atoms substitute Ti and Li while Na substituting Li atoms. Synthesis is conducted through a solid state reaction by using Li_2CO_3 , TiO_2 -anatase, Al_2O_3 and Na_2CO_3 as raw materials. In this study, the effects of substitution of Na and Al in $\text{Li}_4\text{Ti}_5\text{O}_{12}$ on the structure, morphology, particle size, surface area, and electrochemical performance were deep studied. The results showed that the Al doped on the $\text{Li}_4\text{Ti}_5\text{O}_{12}$ was not change crystal structure of $\text{Li}_4\text{Ti}_5\text{O}_{12}$. FTIR results confirmed that the absence of changes spinel structure in fingerprint region when doped Al, with increasing Al doped make textures porous grains, particle size decreases to 20.32 m, surface area increases with highest value of 8.25 m^2/gr , conductivity is increased with the best conductivity $8.5 \times 10^{-5} \text{ S/cm}$, , the working voltage of about 1.55 V and the best cycle stability was obtained on doping Al 0.05 and the maximum capacity is 70 mAh/g. While doping Na in $\text{Li}_4\text{Ti}_5\text{O}_{12}$ caused structural changes to the three phases formed $\text{NaLiTi}_3\text{O}_7$, $\text{Li}_4\text{Ti}_5\text{O}_{12}$, and Li_2TiO_3 . Transformation on the structure is also confirmed by the changes in the fingerprint region with FTIR analysis. While the increase in Al doping causes $\text{NaLiTi}_3\text{O}_7$ phase become dominant, texture of granular becomes bigger and smoother, the particle size decreases to 30.89 m, surface area decreases, the ionic conductivity was stable at $2.5 \times 10^{-5} \text{ S/cm}$, The working potential in 1, 3 V and 1.55 V, the stability of the structure obtained on doping Al 0.05 and the maximum capacity of 90 mAh/g. Overall showed that the addition of Al doped can improve the ionic conductivity while stability of the cycle and the Na doped decrease the working voltage; Synthesis of $\text{Li}_4\text{Ti}_5\text{O}_{12}$ powder doped by Al and Na atoms for lithium ion battery

anodes had been carried out using solid state reaction. Al doped on $\text{Li}_4\text{Ti}_5\text{O}_{12}$ aim is to increase the ionic conductivity and strengthen the structure of $\text{Li}_4\text{Ti}_5\text{O}_{12}$ while Na doped aimed is to decrease the operating voltage. Al and Na doped on $\text{Li}_4\text{Ti}_5\text{O}_{12}$ had been carried out by following equation $\text{Li}(4 - (x / 3 + y))\text{Al}_x\text{Na}_y\text{Ti}(5 - 2x/3)\text{O}_{12}$ ($x = 0; 0,025; 0.05, 0.075$ and $y = 0, 1$) where the Al atoms substitute Ti and Li while Na substituting Li atoms. Synthesis is conducted through a solid state reaction by using Li_2CO_3 , TiO_2 -anatase, Al_2O_3 and Na_2CO_3 as raw materials. In this study, the effects of substitution of Na and Al in $\text{Li}_4\text{Ti}_5\text{O}_{12}$ on the structure, morphology, particle size, surface area, and electrochemical performance were deep studied. The results showed that the Al doped on the $\text{Li}_4\text{Ti}_5\text{O}_{12}$ was not change crystal structure of $\text{Li}_4\text{Ti}_5\text{O}_{12}$. FTIR results confirmed that the absence of changes spinel structure in fingerprint region when doped Al, with increasing Al doped make textures porous grains, particle size decreases to 20.32 m, surface area increases with highest value of 8.25 m^2/gr , conductivity is increased with the best conductivity $8.5 \times 10^{-5} \text{ S/cm}$, , the working voltage of about 1.55 V and the best cycle stability was obtained on doping Al 0.05 and the maximum capacity is

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