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Anode Material for Secondary Battery Technology and Market Forecast

https://marketpublishers.com/r/A570DC0E7BCEN.html
Date: November 2010
Pages: 147
Price: US$ 3,450.00 (Single User License)
ID: A570DC0E7BCEN

Abstracts

The graphite carbon has a layered, planar structure composing graphene layers that hexagonal network planes composed with carbon atoms of sp2 hybrid orbital. The gap between graphene layers is united by Van der waals power.

The graphite carbon means hexagonal graphite that the graphene layers are formed by ABAB....... way in c-axis direction. In the other hand, the rhombohedral graphite structure is partially layered by ABCABC...... way due to changed order of layering. The figure 2.2 shows the unit cell structure of rhombohedral graphite and hexagonal graphite.

The graphite crystal has crystallographic structure composing edge plane, which is parallel to c-axis direction, and basal plane, which is vertical in C-axis direction. Due to this structure, the graphite crystal has an anisotropy physical characteristic.

Also, the structural anisotropy characteristic of graphite carbon affects the electrochemical reaction in negative pole (anode) of Li-ion battery. The basal plane is relatively inactive about electrochemical reaction while the edge plane is very strong active. Therefore, the electrochemical is affected by relative ratio of basal and edge plane in graphite carbon. So because of the strong reaction of graphite carboneous edge plane, it is easy to absorb surface group including oxygen in the air.

Mesophase pitch is formed as intermediate phase while the isotropy melting pitch or is formed by extracting from the pitch that is made by selective extraction. in the figure 2.14, the extracted spherical mesophase by pyrolysis of pitch is generally called as 'Brooks-taylor type' During pyrolyzing the pitch, if the proper size(10-30 micrometer) of round bids are became, the pitch is cooled and mesophase bids are separated by

dissolving the proper solvent. Then heat-treatment for graphite is implemented after forming the surface protective film by heat treatment of mesophase bids in the air mixed with oxygen and moisture. The graphitized MCMB, which is made by this way, is spherical particle as you can see in the figure 2.15 and shows outstanding characteristic of anode material for lithium secondary battery.

When electrode is manufactured, the spreading process is convenience because of the spherical particles. The high energy density of battery can be obtained by high electrode density and also declines in irreversibility capacity can be reduced with small specific surface.

It is easy to insert lithium and is shown outstanding rate features when charging/recharging because most surfaces of MCMB are composed with edge-plane surface of graphite

However, it is not well-used currently because of the need for heat treatment at high temperature and large amount of solvent uses.

As the new anode material for high capacity lithium secondary battery, the characteristics required for anode material instead of conventional graphite is similar with the following conditions of anode material replacing lithium metal.

If charging or recharging, insert Li-ion and lithium metal for electric potential of recession.

Less difference with potential. This is for having high battery voltage when composing battery and positive/negative poles.

Have high charge/recharge capacity rather than graphite (Capacity per unit weight and capacity per unit volume)

Less loss of initial irreversibility.

Outstanding charging/recharging cycle characteristics.

High ion diffusion velocity and electrical conductivity in active materials.

Maintain the structural stability of electrode because of less change in volume by Lithium insertion/secession.

Be easy to manufacture and low cost.

The typical high capacity metal atoms, Si, Sn, Sb, and Al are known for formation of lithium-metal alloy by reaction with lithium. The figure 3.1 and 3.2 represents the theoretical lithium storage capacity and electric potential range of lithium reaction with those metal atoms. Most of metal reaction electric potential is below 1V compared with lithium metal electronic potential. In particular, Si has similar reaction electric potential with graphite carbon. Those metallic atoms show high lithium storage capacity rather than graphite.

In particular, Si has high capacity over 4000 mAh/g theoretically. But if considering weight and volume after lithium reaction, graphite carbon is less changed whereas the capacity of high capacity atoms, Si and Sn, are largely reduced. This is because great changes in bulk happen when high capacity metal reacts with lithium. The figure 3.3 represents the volume changes before and after reacting with lithium, showing 10% of the volume change of graphite while 300% volume change of Si.

Si/Sn (Silicon/Tin) and LTO are used, mostly Si/Sn are usually called as metallic. As mentioned, the development and research on non-carbon is ongoing. The capacity of carbon is 350mAh/g whereas the non-carbon (Si 4,000mAh/g, Sn 994mAh/g, Al 993mAh/g, Silica Li2SiO 850~1,200mAh/g and Metal Lithium 3,860mAh/g) has 10 times higher capacity so it is very attractive for electric vehicles and high-power secondary battery.

Anode material for Li-ion secondary battery is expected to be increased about 2.2 times with annual 17.3% growth rate, starting from 19,412 tons in 2009 to 43,120 tons in 2014

Strong Point

The world first report specialized in anode materials for Li-ion secondary battery

Carbon and Non-carbon anode materials technology and Recent forecast of Industries

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