Development of cobalt-free oxide positive electrode material for lithium-ion batteries

Realization of high discharge voltage close to that of existing positive electrode material

We have developed two cobalt-free positive electrode materials, $Li_{1+x}(Fe_{0.2}Ni_{0.2}Mn_{0.6})_{1-x}O_2$ and $Li_{1+x}(Fe_{0.2}Ni_{0.4}Mn_{0.4})_{1-x}O_2$ ($0<x<1/3$) containing a cheap and environmental-friendly element, iron (20 % of total transition metal content), using the coprecipitation – hydrothermal – calcination method. Both materials have not only high specific capacity of above 180 mAh/g, but also high average discharge voltage of 3.5–3.7 V. The observed discharge voltage is comparable with those of existing positive electrodes like $LiNi_{1/2}Mn_{1/2}O_2$ and $LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$ (4.0 V) and higher than that of our previously developed material $Li_{1+x}(Fe_{0.5}Mn_{0.5})_{1-x}O_2$ (3.0 V). We believe that the utilization of iron in oxide-based positive electrodes will be accelerated by using these newly developed materials.

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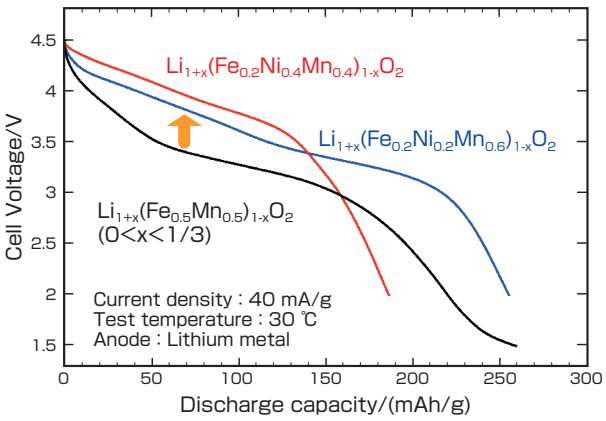

Initial discharge curves of two newly developed positive electrodes (red and blue) and a previously developed one (black) after charging up to 5 V

A black coating developed using structured carbon nanotubes

An excellent light absorber and thermal radiator like a black body

We have developed an excellent black coating which absorbs light almost perfectly across a very wide spectral range from ultra-violet to far-infrared. This black coating is fabricated with vertically-aligned single-walled carbon nanotubes (SWCNTs) which are directly synthesized on substrates by *Super-growth*, a novel synthesis method developed by AIST. Owing to its nanometer-scale structure, the SWCNT coating exhibits high light absorption rate of 98-99 % uniformly in an extensive spectral range from 0.2 μm to 200 μm. This optical feature is quite similar to the black body, a theoretical material that absorbs all incident light. From an industrial viewpoint, this black coating will contribute to improvements in solar energy conversion, infrared detector, heat release in electronic devices etc. Metrologically, better black coating is also expected especially in the infrared region in order to fully cover the Planckian curve.

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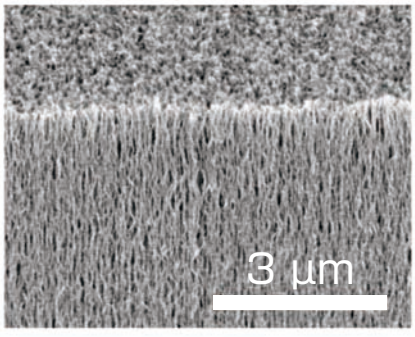

Scanning electron microscope (SEM) image of the black coating