**Intellectual Property and Enterprise**

**BIOX: Amorphous iron oxide nanostructures of bacterial origin for applications including anodes for Li ion batteries.**

Professor Jun Takada, Graduate School of Natural Science and Technology

"Iron-oxidizing bacteria" produce extracellular, uniquely-shaped microsheaths or fibrous bundle nanostructures comprising mainly of iron oxides—known as Biogenous iron oxides (BIOX)—ubiquitously in natural hydrosphere at ambient temperature (Fig. 1).

Although BIOX has been generally recognized as waste, we have studied its properties for as yet unknown potential industrial applications. Our careful and focused studies revealed BIOX matrix to have the following physical properties: (i) an amorphous state; (ii) consist of organic/inorganic hybrid of nanoparticles of approximately 3 nm diameter; (iii) the nanoparticles are composed of many elements, C, O, Fe, Si and P; (iv) inorganic elements are linked via oxygen (Fig. 2).

Importantly, BIOX has a far superior potential (for example a large capacity) as an anode material of Li-ion batteries compared to conventional carbon anodes. In addition, BIOX exhibits an amazing, wide range of functions compared with other materials currently: (i) higher catalytic potential; (ii) higher affinity to human cells; and (iii) brighter color property (Fig. 3). All these characters are superior to those of artificially synthesized iron oxides. We are confident that the eco-friendly, nontoxic, and low-cost BIOX will be a next-generation functional material.

Detailed studies of an isolated strain of one type of the bacteria led us to elucidate the incipient mechanism of BIOX formation. Our experiments showed that extracellular secretion of bacterial polymers triggers deposition and binding of aquatic inorganics such as Fe, Si, and P, which results in...
the unique organic/inorganic hybrid. Further analysis is in progress for a greater insight into how the mechanism and mode of chemical linkages in the BIOX matrix contribute to the aforementioned functions.

Technical publications:


Fig. 4. Tubular iron oxide produced by bacteria (diameter is 1/1000 mm)