Unique Organic/inorganic Hybrid Material Produced by An Aquatic Iron-oxidizing Bacterium, *Leptothrix* sp. – Properties and Practical Functions

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Most people have experienced to see yellowish orange precipitation or float in springs, ditches, or streams where groundwater outwells (Fig. 1).

Fig. 1

We discovered that this unlovely precipitation was a mass of very complicated unique structure produced by Fe/Mn-oxidizing bacteria.

A type of aquatic Fe/Mn-oxidizing bacteria, the genus *Leptothrix*, produces uniquely-shaped microsheaths (ca. 1 μm in diameter) ubiquitously in natural hydrosphere at ambient temperature (Figs. 2, 3).

The sheath is characterized by an extracellular, microtubular, Fe- or Mn- encrusted structure. Basic sheath- construction proceeds in two steps under culture conditions: i) release of saccharic and proteinous fibrillar exopolymers from bacterial cells and their initial assemblage and ii) the chemical interactions between the organic exopolymer fibrils and aqueous-phase inorganic ions (Fig. 4).

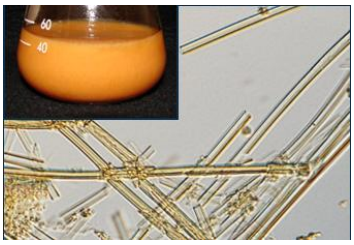

Fig. 2

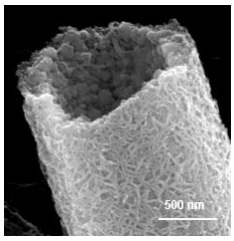

Fig. 3

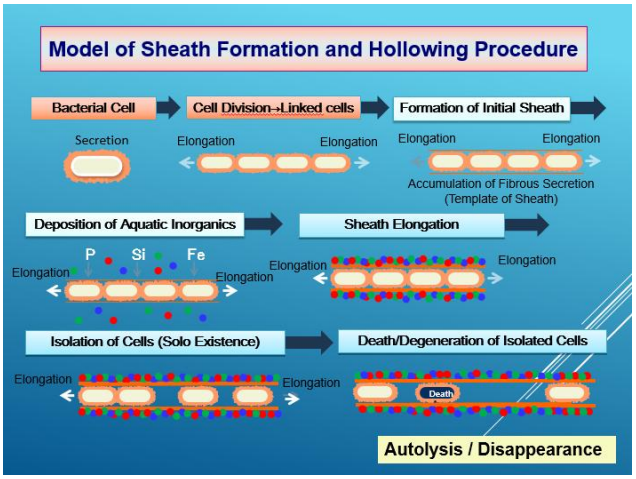

Fig. 4

The sheath is characterized by i) being composed of Fe, Si, P [approximate rate (atomic %): Fe:Si:P=75:20:5], and often Ca, ii) having Si and P linked with Fe via O, and Fe existing mainly as iron oxides, iii) Almost homogenous distribution of these elements in the sheath texture, iv) amorphous texture composed of nano-scaled particles (ca 3 nm diameter).

Taken together, the sheath material is a unique organic/inorganic hybrid which is difficult to be synthesized artificially. It is extremely noteworthy that the sheath material has a superior potential (large capacity etc.) as an anode material of Li-ion battery to that of broadly-used carbon anode (for detail see ref. 1). In addition, the sheath material exhibits amazingly wide-ranged functions as i) bright reddish color applicable to pottery (Fig. 5, see ref. 4), ii) efficient enhancer of catalyst activity (Fig. 6, see Ref. 2, 3), iii) high affinity to human cells, and iv) plant protection activity against diseases.

We place our hopes and expectations on the eco-friendly, nontoxic, low-cost material of bacterial origin as fascinating functional material for the near future.

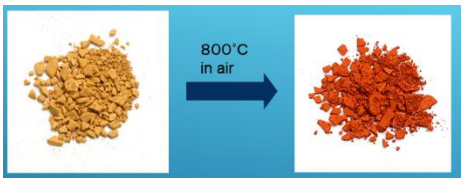

Fig. 5

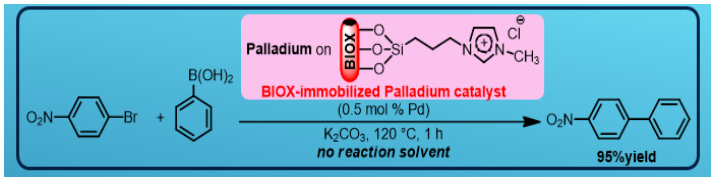

Fig. 6

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