- FY2016 Jun Takada (Professor, Okayama University)

Toward Creating Innovative Applications to Harness the Novel Functions of Nano-scaled Iron Oxides of Microbial Origin

Research Project Outline (From Oct. 2012 to Mar. 2018)

Structural and functional analyses of unique Fe oxides of bacterial origin , BIOX, and their mimic Fe oxides artificially synthesized

1. Fe oxides produced by bacterial culture: Creation of novel nano-scaled Fe oxides by culturing an isolated Fe-oxidizing bacterium (*Leptothrix cholodnii* strain OUMS1) under altered conditions.
2. Synthetic Fe oxides: Creation of novel nano-scaled low cryrstalline Fe oxides by using chemicals and comparison of chemical properties of the products with the bacterial BIOX.

→ **Towards creation of novel eco-friendly innovative functional materials [e.g., materials for electrode of Li ion rechargeable battery, high affinity to human cells available for 3D culture, efficient catalytic agent, high grade pigment, plant protectant, etc.]**

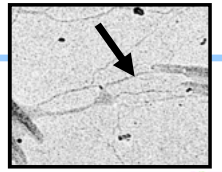
Microtubular Fe oxides produced by culturing OUMS1 (right)

Research Results (FY2016)

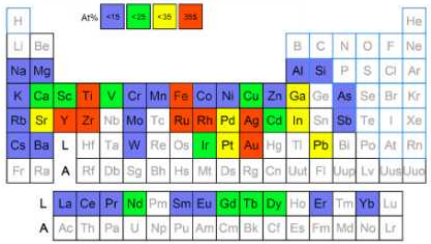
◆ Sorption of metallic and nonmetallic elements by nano-scaled fibrils of BIOX

✓ Focusing attention on cation encrustation of *Leptothrix* sheaths, we examined sorption capability of nano-scaled fibrils enzymatically/chemically isolated from OUMS1 sheaths to metallic and nonmetallic elements. All of 47 test elements were sorbed to the fibrils. High sorption degrees were shown using the solution Ti, Y, Zr, Ru, Rh, Ag, Au, Cu, or Pt. ***Water Res. 122, 139-147(2017)***

✓ The contribution of NH_2 functional group in the OUMS1 sheaths to sorption of Fe(III) minerals was examined. Fe(III) minerals were sorbed to the sheaths but not to the NH_2–masked sheaths. The parallel experiments using NH_2 -holding chitosan and NH_2–covered polystylene beads provided similar results. The experimental outcomes proved the critical role of NH_2 on the metal encrustation. . ***Sci. Rep. doi:10.1038/s41598-017-06644-8.***



Enzymatically/chemically isolated nano-scaled fibrils (～8 nm in diameter)



Sorbed elements to the fibrils

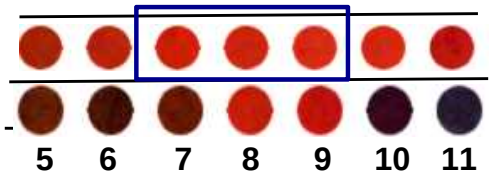
◆ Creation of bright-colored Al-sorbed iron oxides

Sorption of various metallic elements to cultured sheaths was sought by culturing OUMS1 under varied conditions for creation of novel types of Fe oxides.

✓ The previously formed immature sheaths were treated with a solution mixture of Fe(II) and various cations. The continuous treatment resulted in forming microtubular Al-, Ru-, or Ti-sorbed Fe oxides. Results showed that unique types of Fe oxides which sorb desirable metals can be created by modification of culture conditions of OUMS1.

✓ Thus-created iron oxides sorbing 40% of Al turned bright reddish pigment by heating 700－900 ℃. This type of pigment could be useful for pottery and cosmetic manufacture.

Patent applied (appl. No.(2016)207362)



Heat temperature (x 100 ℃)

Color change of Al-sorbed Fe oxides by heating (▭ : brightest reddish color)
Upper: created Al-sorbed Fe oxides
Lower: natural BIOX