**Chemical states change of heavy elements by interaction with microorganisms**

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**Introduction**

Actinide migrations are of great concern in the environment because of their radioactivity and long half-lives. Their migratory behavior depends on their oxidation states [1] that differ among the III, IV, V, and VI. We have investigated chemical states change of actinides and lanthanides by the interaction with microorganisms. So far, we have elucidated the arsenic behavior around acid mine [2] by the contact with Mn oxidizing bacteria [3], adsorption of U(VI) by the mixture of microorganism and kaolinite clay [4], chemical states change of Ce(IV)-desferrioximine B (DFO) complex by the adsorption to microorganism [5] by the XAFS study at BL-27A and B. In 2006, we have conducted the following investigations:

i) Oxidation states change of Cu(II) with lichen mycobiont.

ii) Precipitation of uranium by reduction on indium-tin-oxide electrode.

**Oxidation states change of Cu(II) with lichen mycobiont**

We have been studying the tolerant mechanisms to Cu in a Cu tolerant mycobiont from Tremolecia atrata (rusty-rock lichen). T. atrata mycobiont-cell aggregate, whose shape is almost spherical, showed higher growth in the presence of 0.4 mmol dm⁻³ Cu(II)SO₄ compared to that in its absence but the growth was deteriorated at 1.6 mmol dm⁻³ Cu(II)SO₄. To clarify the chemical states change of Cu(II) by the mycobiond, the XANES analysis was carried out. Approximately 1 g of fresh T. atrata mycobiont-cell aggregates were inoculated into a 25-cm³ MY medium with 1.2 mmol dm⁻³ Cu(II)SO₄ in a 100-ml Erlenmeyer flask. The pH of the medium was approximately 4.7 before inoculation. The cell aggregates were incubated on a rotary shaker at 120 rpm in the dark at 20 °C for 336 hours. The cell aggregates were harvested by centrifugation and washed with purified water and then with 1 mmol dm⁻³ HCl. The resulting cells were freeze-dried and sealed three-fold in polypropylene bags after exchanging the air in the bags with Ar gas. Zeolite antioxidants were put in the polypropylene bags to prevent the alteration of the oxidation states of Cu in the reference substances. Oxidation states of Cu in the cell aggregates and reference substances were examined by X-ray absorption near edge structure (XANES) spectroscopy of the Cu Kα₁.

XANES spectra of the samples revealed that the Cu absorbed in the T. atrata mycobiont was predominantly divalent and the oxidation state was maintained through stable complexation of Cu(II) with cell-wall components, such as melanins. Some faction of Cu(II) was reduced by glutathione (GSH), which was induced in T. atrata mycobiont by exposure to Cu(II)SO₄.

**Precipitation of uranium by reduction on indium-tin-oxide electrode**

We observed accumulation of uranium caused by reduction of U(VI) on indium-tin-oxide (ITO) electrode surface using the XANES spectroscopy at LIII-edge absorption spectra of the uranium on ITO electrode after the reduction at -0.3 V for 1200 s and found that U(IV) on ITO surface. This result indicated that U(VI) was reduced to U(IV) and accumulated on ITO electrode surface. We also obtained time-resolved optical waveguide (OWG) spectra. At present, precipitation mechanism is in consideration.

**References**


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