

# TOKORO LAB.

## Resource Circulation, Separation-Concentration Powder Processing



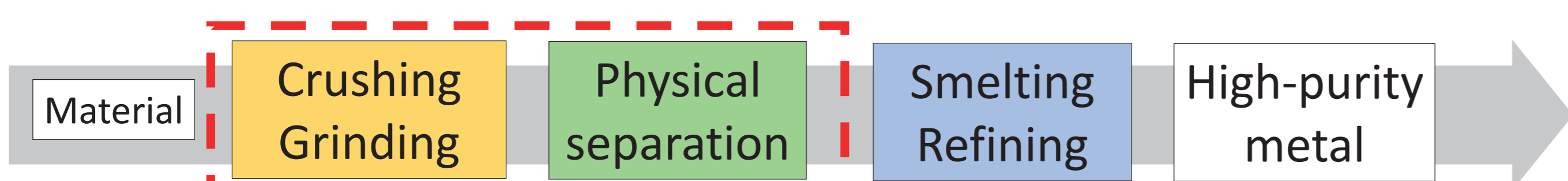
Endowed Research Unit for Non-ferrous Metal Resource Recovery Engineering  
(JX Metals Endowed Unit)

Environmental Resource Processing Engineering

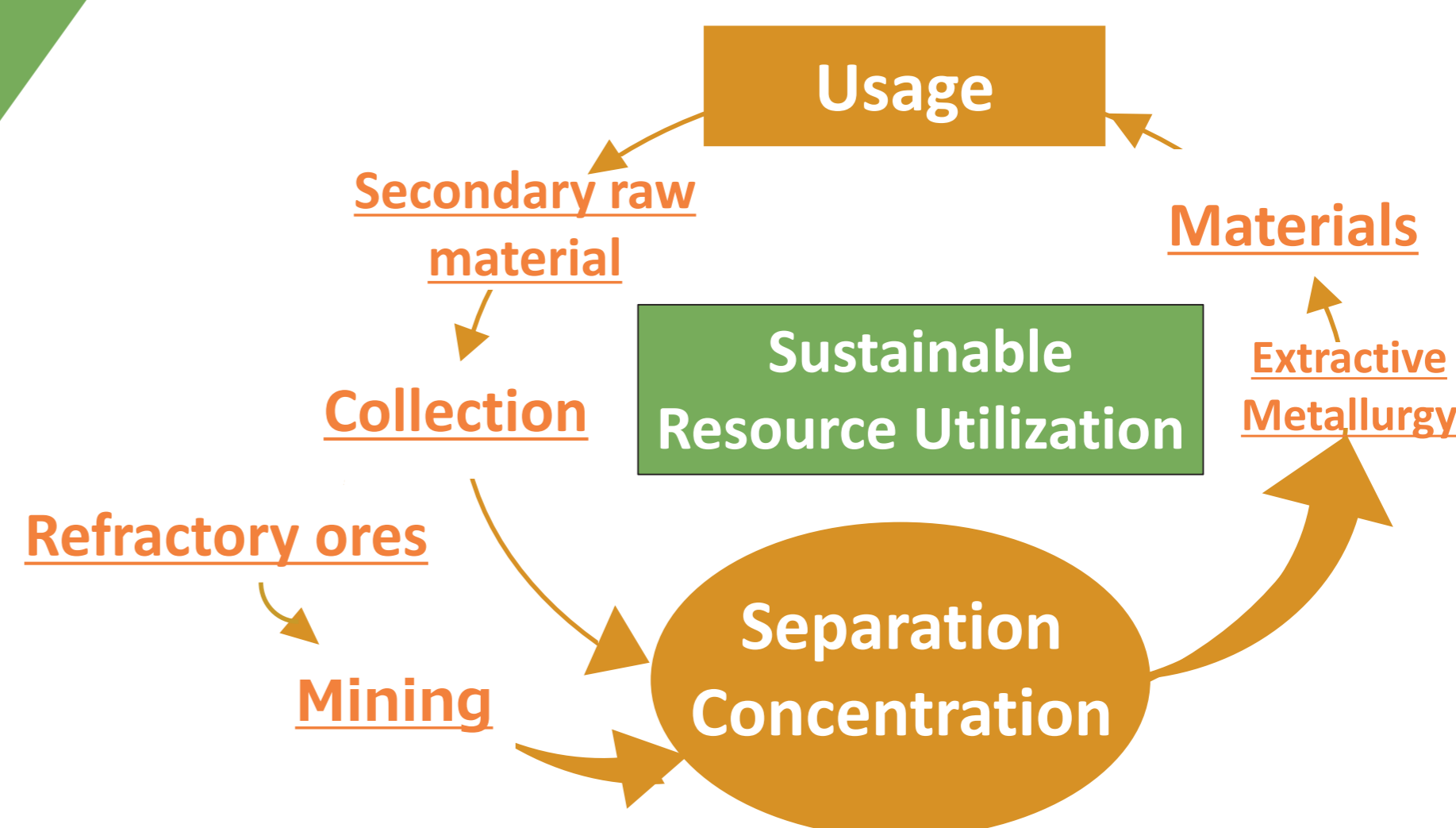
<http://www.tokoro.env.waseda.ac.jp/>

### Technologies for Resource Circulation / Environmental Restoration

Valorization of the urban mine resources and refractory ores by advanced technologies for solid separation and concentration.

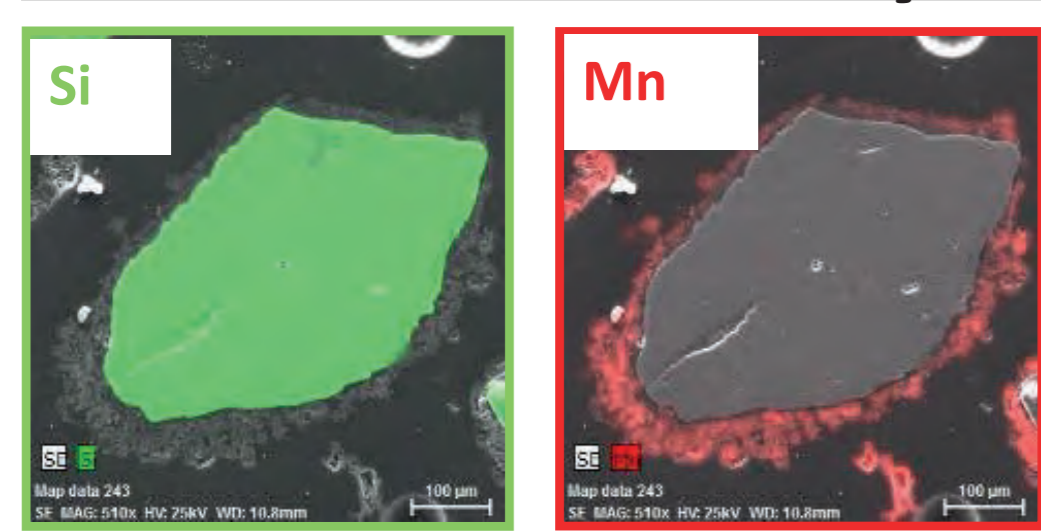


Technologies for separating and concentrating solids to determine overall process efficiency

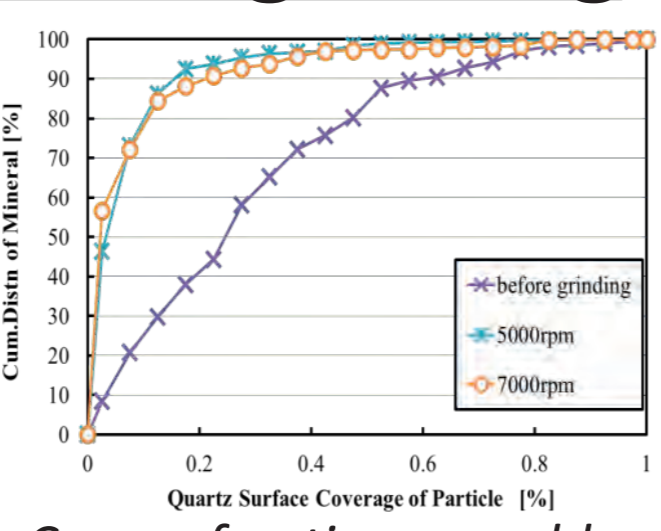


### Special Grinding Technologies for Separation of Solids

#### Soil Remediation by surface grinding



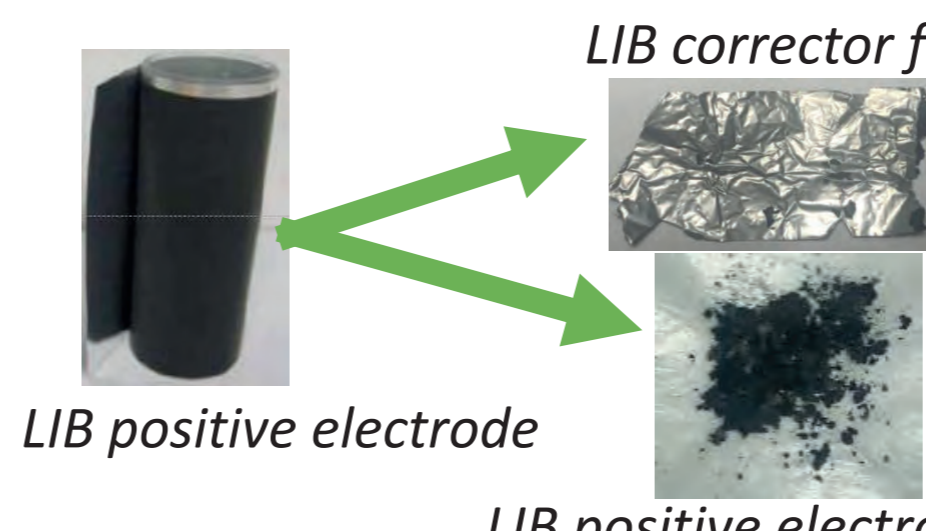
Filtration sand before surface grinding



Course fraction reusable as purified soil

- Increase of SiO<sub>2</sub> exposure by removal of surface Mn
- Concentration of Mn into a fine particle fraction

#### High-selective separation by novel electric pulsed charge

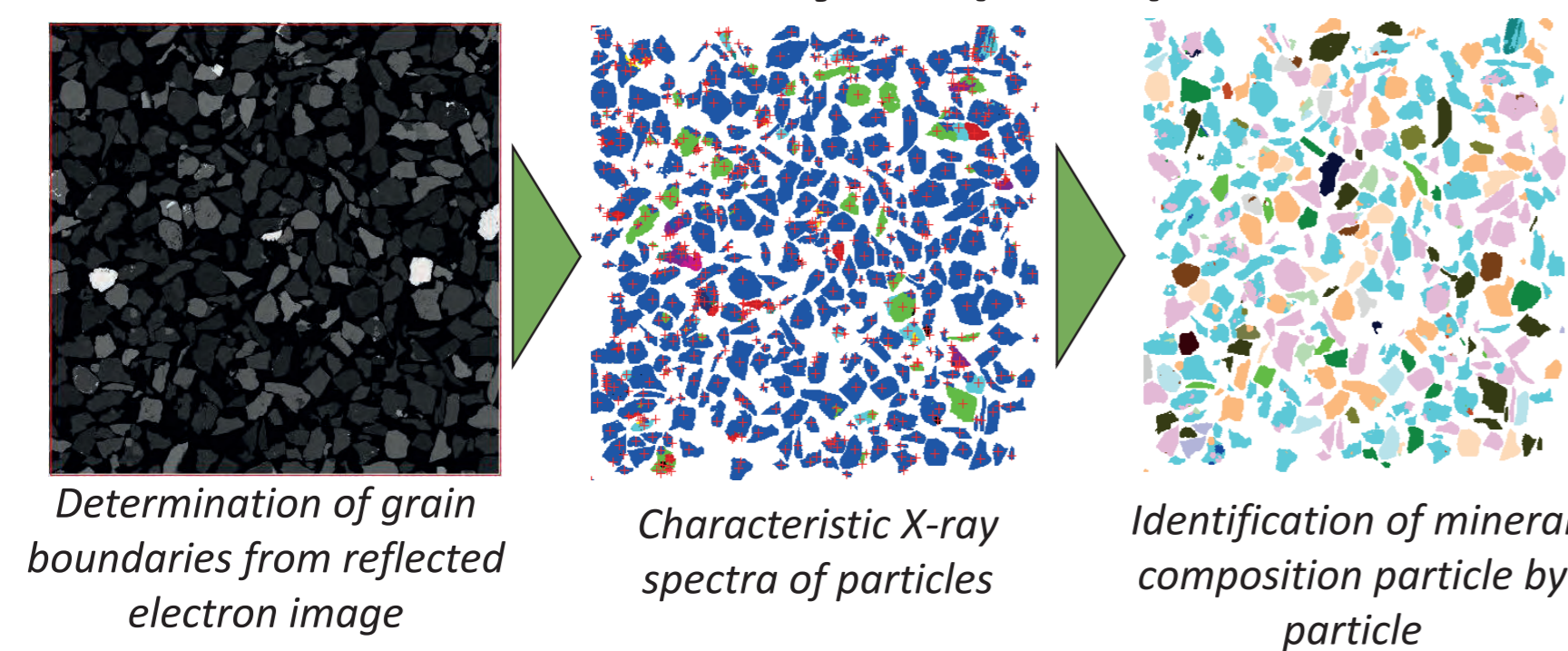


LIB positive electrode particles

- Selective separation and peeling at interface by control of voltage, current, resistance and discharge path in electric pulsed charge
- Creating a new recycling loop

#### Solid analysis to investigate the mineral separation

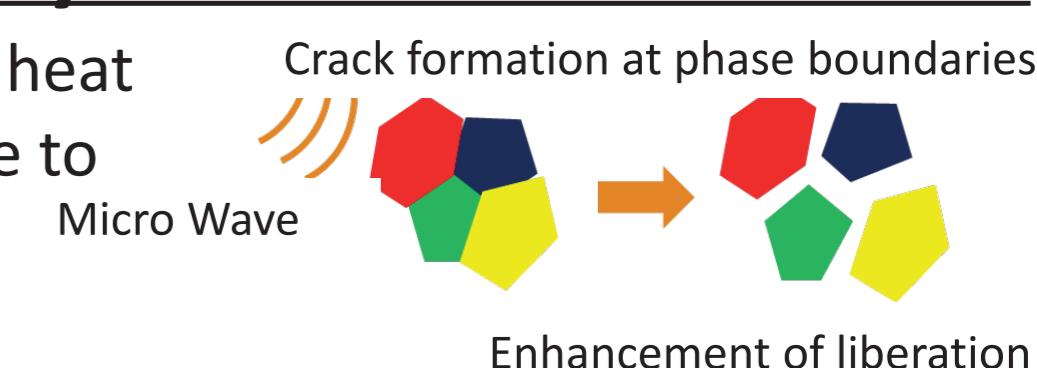
##### Mineral Liberation Analyzer (MLA)



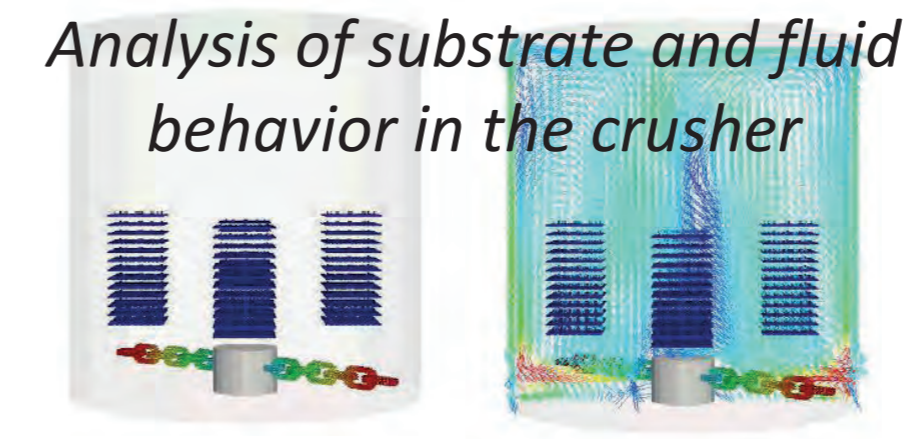
- Identification of the mineral phases
- Quantification of liberation degree and weight ratio of each mineral

#### Control of minerals separation by microwave irradiation

- Selective liberation of mineral phases by heat
- a. crack formation at phase boundaries due to different thermal expansion
- b. selective change of surface properties



#### Optimization of grinding operations by simulations

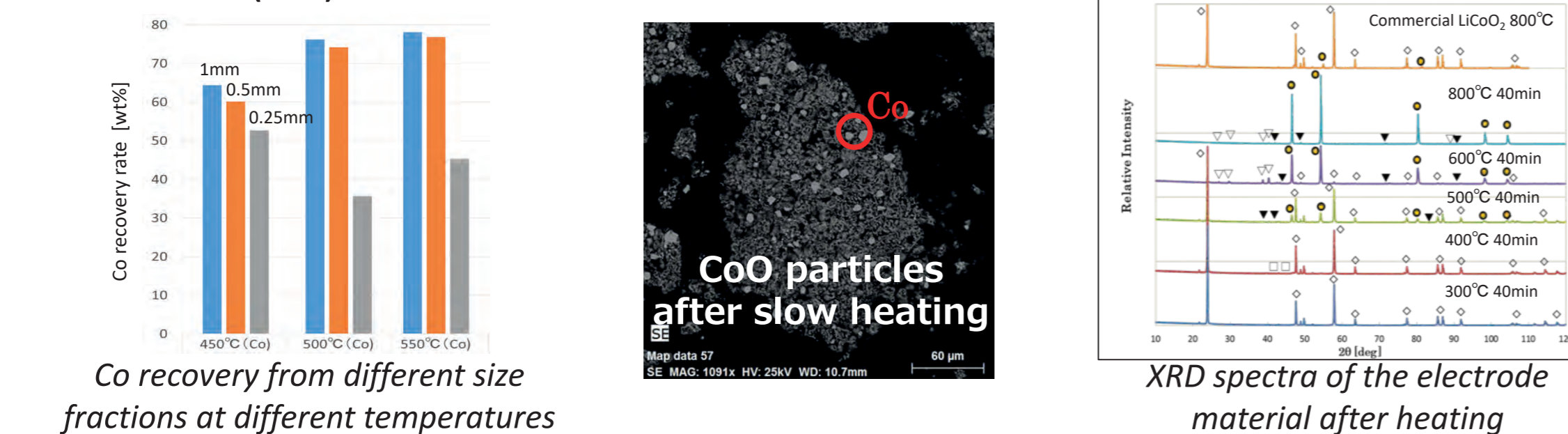


- Estimation of grinding performances by analysis of collisions between stirrer and substrate
- Possible elucidation of stirring and granulation mechanisms

### Pretreatment Operations for Improving the Solid Separation

#### Recovery of Co from Li-Ion batteries by slow heating

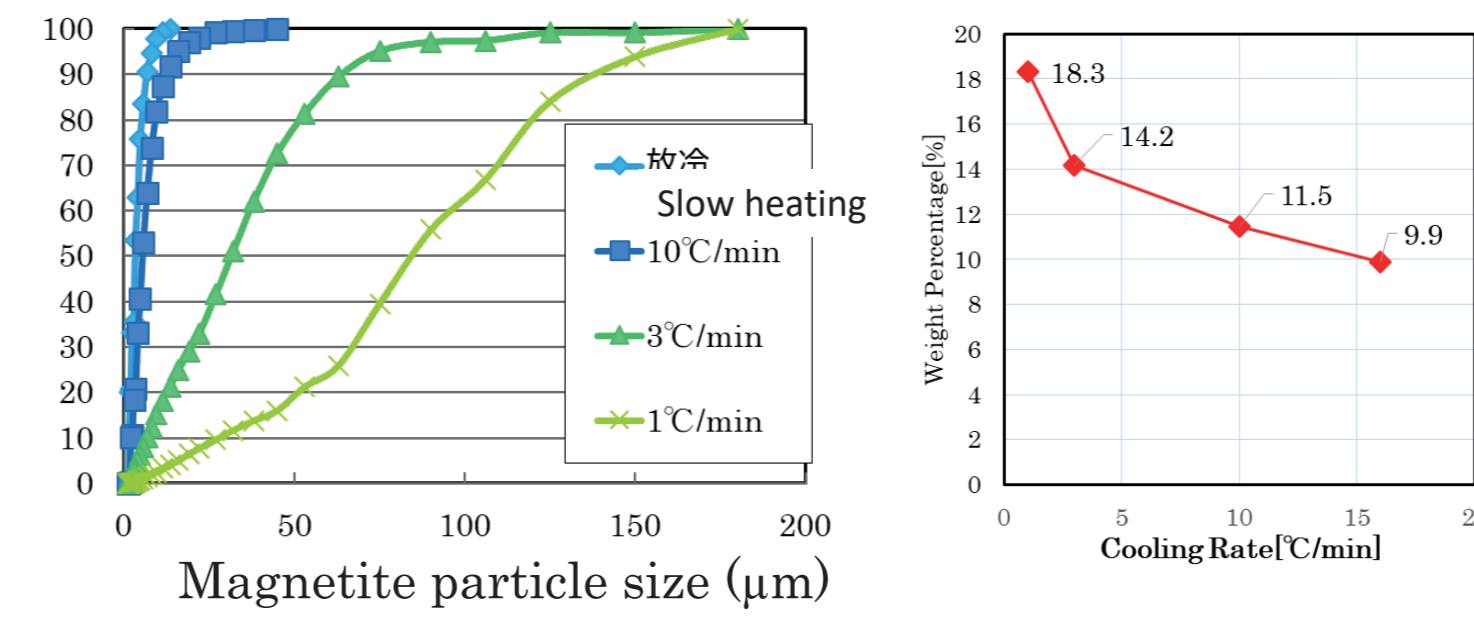
- Process analysis to improve the recovery of valuable metals from Li-ion batteries (LIB)



Co recovery from different size fractions at different temperatures

#### Recovery of magnetite by slow-cooling crystallization

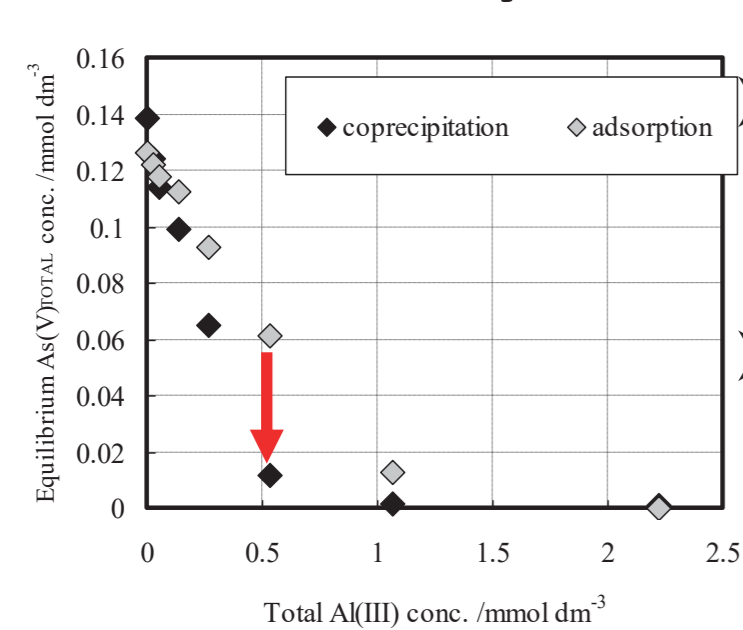
- Study of the separation of magnetite from an amorphous phase slag via smooth-cooling crystallization and magnetic separation



- Magnetite particle size and precipitation rate increased by decreasing the cooling rate

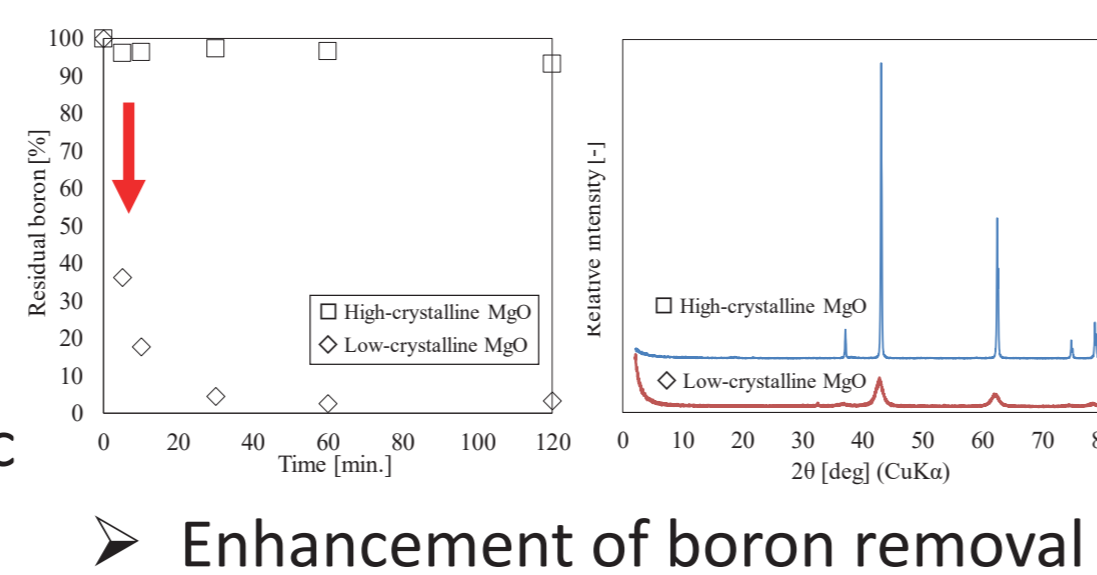
### Advanced Technologies for Environment Remediation

#### As removal by surface precipitation



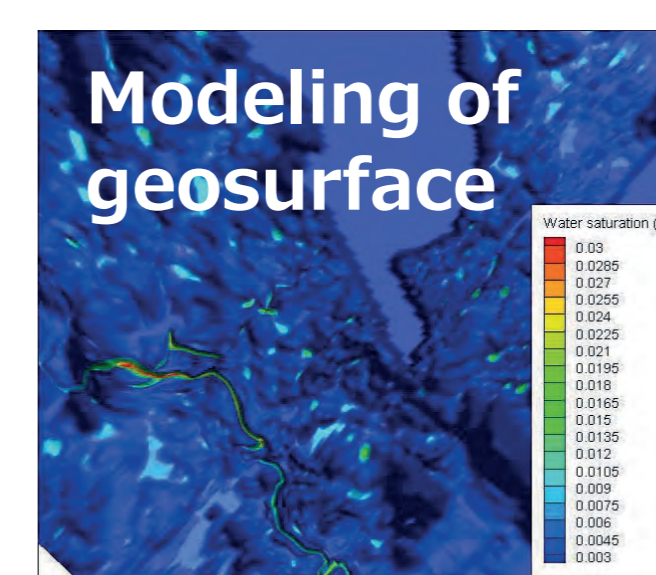
- Study and optimization of surface precipitation
- Removal and recovery of inorganic elements in high efficiency

#### Removal enhancement by amorphization



- Calcination of MgCO<sub>3</sub> to MgO and quenching to suppress crystallization
- Enhancement of boron removal

#### Process optimization by combination of geochemical modeling and fluid analysis



- Creation of ground model from terrain data and reproduction of the dynamic shape water bodies
- Prediction of concentration profiles by considering chemical equilibria

