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MOLTEN2024

Visualization of Molten Slag Suspension by Electrical Resistance Tomography

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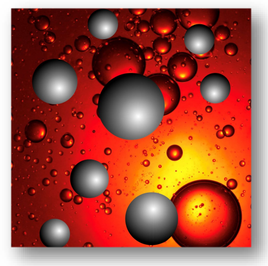
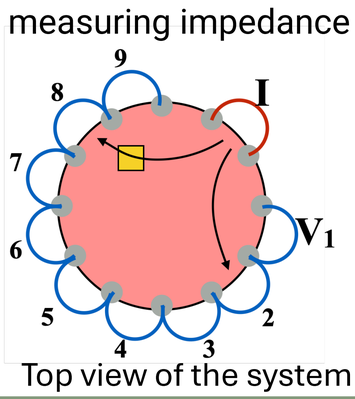
Introduction

- Slag is a multiphase mixture composed of liquid matrix with dispersed solid phases.
- Since the physical properties (i.e. viscosity and conductivity) of slag are strongly influenced by the state of the solid phases inside of molten slag (i.e. presence, size, and distribution).
- In this study, Electrical Resistance Tomography (ERT) method was applied to the molten slag in order to visualize its inside situation



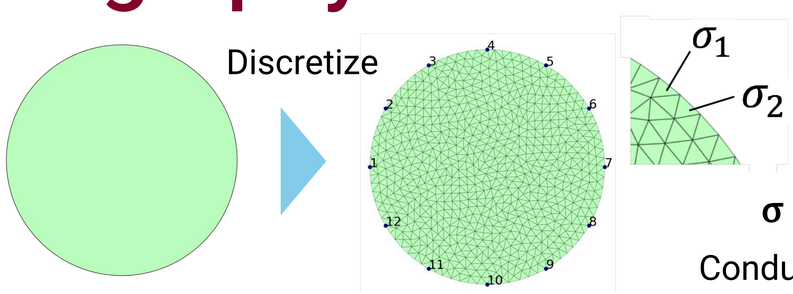
About Electrical Resistance Tomography method

- Electrical Resistance Tomography (ERT) is a method for image diagnosis widely used in a medical field such as MRI and CT[1)].
- The inside of the system was mapped as the conductivity distribution by measuring impedance with multi electrodes under a weak electric current.



Top view of the system with electrodes.

Impedance are measured at nine points for each set of current application electrodes. For homogeneous samples, the measurement data will display a U-shaped pattern.



$\boldsymbol{\sigma} = (\sigma_1,\ \sigma_2, \cdots)$

Conductivity distribution

Iterative method[2)]

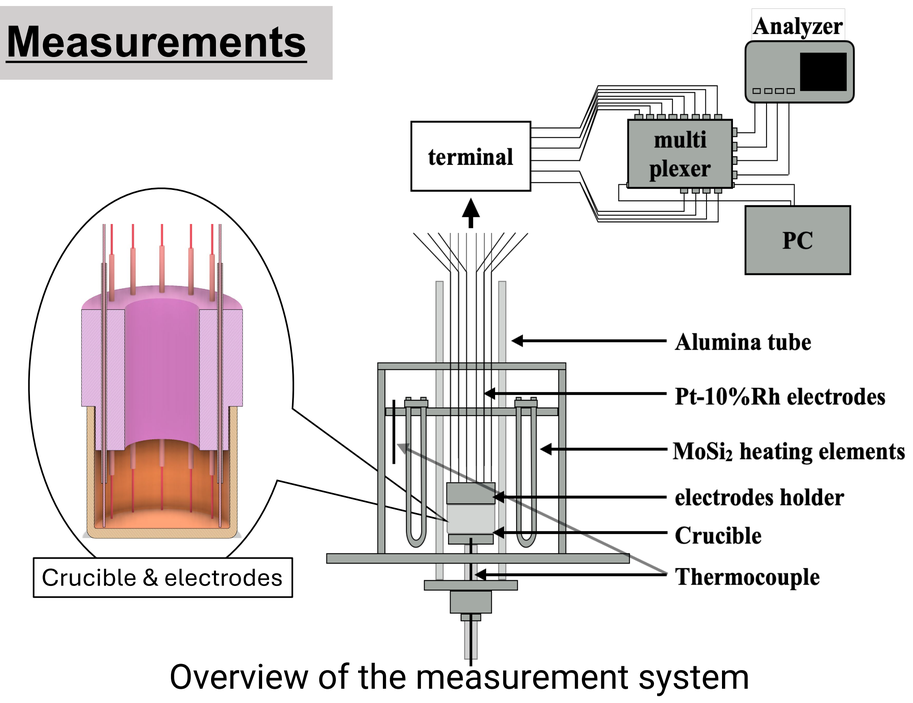
$$\boldsymbol{\sigma^{i+1}} = \boldsymbol{\sigma^{i}} + \mathbf{A}(\boldsymbol{R^{experimental}} - \boldsymbol{R_i^{simulated}})$$

i: number of iteration
R: resistance
A: regularization matrix

1. Start equation from a uniform initial conductivity $\boldsymbol{\sigma^0}$
2. Estimate $\boldsymbol{\sigma^{i+1}}$ from the difference value $\boldsymbol{R^{exp}} - \boldsymbol{R_i^{sim}}$
3. Repeat until $\boldsymbol{R^{exp}} - \boldsymbol{R_i^{sim}}$ is small and $\boldsymbol{\sigma^{i+1}}$ is convergent

Visualization by ERT method

Measurements



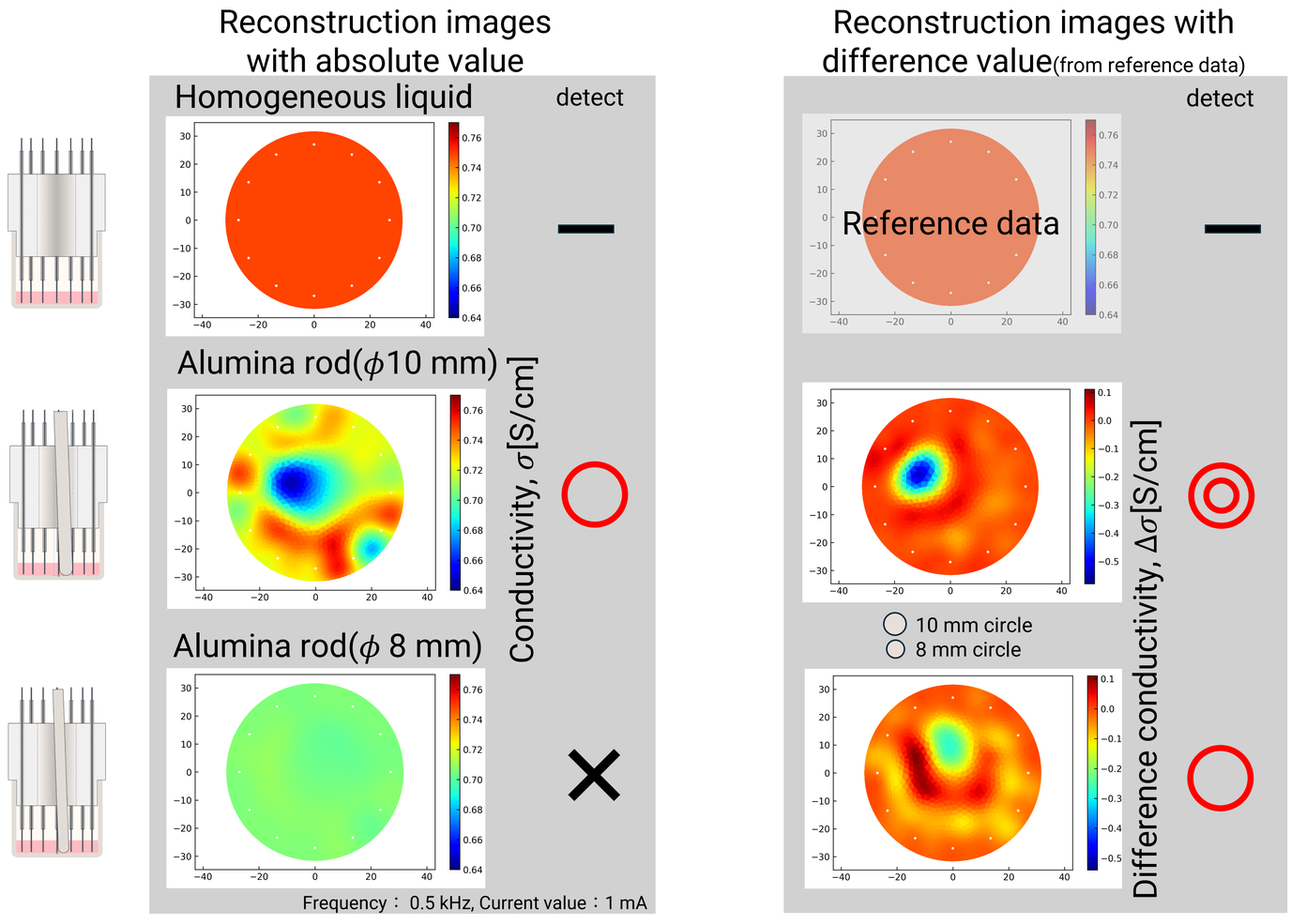
Overview of the measurement system

Sample

Sample composition：45CaO-45SiO_2-10Li_2O(mol%),
Melting point：1290 ˚C[2)]
Initial crystal：$CaSiO_3$(non-conductivity)
Crucible：Alumina(ϕ70 × ϕ63×H60 mm)

1. keeping the temperature, 1370 ℃
2. immersing alumina rod(10, 8 mm) in the sample

Visualization for conductivity distribution



- The solid phase in the molten slag was visualized well by ERT method.
- The detection limit by the current system was estimated to be 8 mm in diameter with difference value reconstruction.

Conclusion

- ERT method was applied to molten slag and the inside situation was well visualized.
- We are currently challenging
  1. improving resolution by optimize the system (crucible size, noise problem, etc.).
  2. visualize the crystallization of the molten slag.
  3. adopting the developed system for real slag (complex composition materials).

References

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