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Possible metal speciation in the fly ash produced from a fluidized bed incinerator of municipal solid waste

Astryd Viandila Dahlan[1], Hiroki Kitamura[2], Hirofumi Sakanakura[2], Takayuki Shimaoka[3],Takashi Yamamoto[2], Fumitake Takahashi [1]

[1] Global Engineering course for Development, Environment, Society, School of Environment and Society, Tokyo Institute of Technology
[2] Center for Material Cycles and Waste Management Research, National Institute for Environmental Studies
[3] Faculty of Urban and Environmental Engineering, Graduate School of Engineering, Kyushu University

Background

80% municipal solid waste in Japan treated by **incinerator.**

Fly ash is by products after incinerator contains heavy metals.

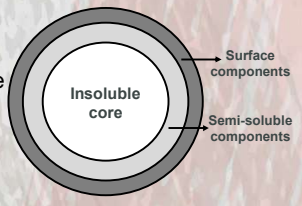
Metals are either carried along with the flue gas and are enriched in mineral aggregates (quartz, feldspar, wollastonite, glass) or vaporized and condensed as chlorides or sulfates. These **metal associations determine the mobilization of metals** during subsequent leaching processes.

Objective

To investigate **new possible metal speciation** at **the individual particle level** from fluidized bed incinerator by using the SEM-EDX

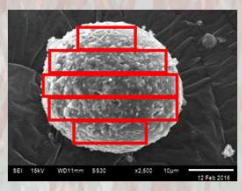
Methodology

1. Fly ash from fluidized bed incinerator. MSWI fly ash have 3 components which are **surface, semi-soluble and insoluble core** components.



2. Line profile analysis for each horizontal section was conducted based on elemental mapping data of measure elements. This study focused on **a section of an individual fly ash** particle.

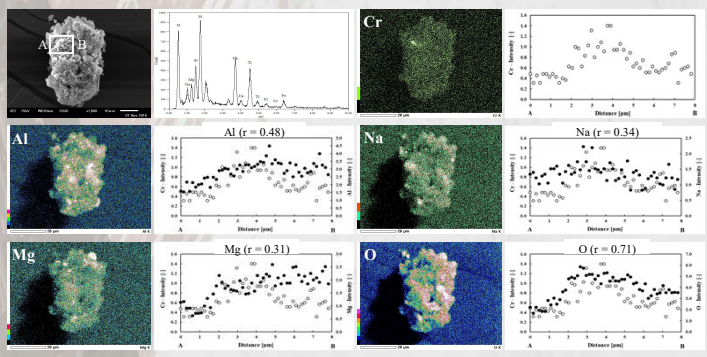
3. **Correlation coefficients (r)** between major elements and metal were calculated based on the intensity data in each horizontal section. The correlation coefficient is a numerical measure of the strength of the statistical relationship between two variables.



Results

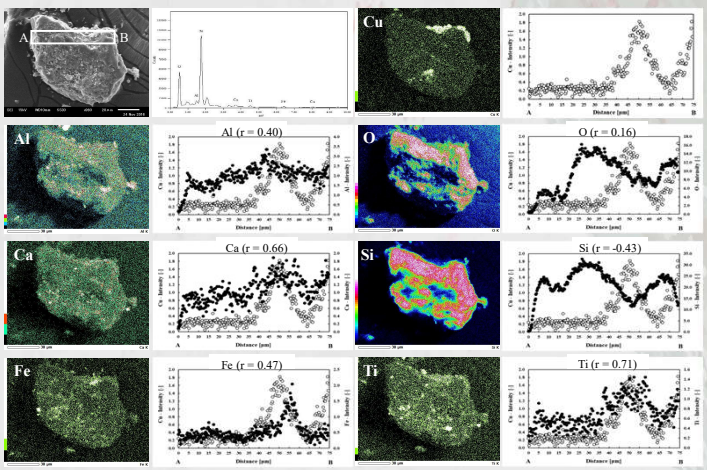
Chromium (Cr)

Chromium (Cr) was mostly detected in the core of fly ash from a fluidized bed. Although Cr was barely detected due to lower concentration remained in the fly ash particles. The chromium-bearing phase was commonly detected as **Cr_2O_3 and $CaCrO_4$** in the MSWI fly ash. The positive correlation between Cr with other elements was obtained by correlation analysis.



Cr shows a positive correlation with Mg were shown in Figure above, that offered new possible Cr speciation is **magnesium chromium spinel ($MgCr_2O_4$)**. There is a possibility during the incineration process, Cr formed into magnesium chromium spinel. A positive correlation with Al also observed in this fly ash particle. It might be suggested new possible metal speciation as Cr_2O_3 included in the Al-based core of fly ash. Al present in the fly ash can control Cr leaching by reducing Cr(VI) released from the solid phase by dissolution into Cr(III) formed. Therefore, the **Al-based matrix in the fly ash might inhibit Cr leaching into the environment**.

Copper (Cu)



SEM-EDX rarely detected copper (Cu) due to lower concentration present in the fly as particles. Cu was commonly detected as **brass and copper oxide**. Cu also has positive correlation Al, Ca, and Fe, as in above Figure. Therefore, the Cu speciation is estimated **as CuO that incorporated with Al/Ca-based insoluble core**. Cu has a negative correlation with Si in observed particles that suggested CuO not included in the Si-based insoluble core. It was explained that CuO and SiO_2 have no reaction, and SiO_2 showed a minor role in the immobilization of Cu. The positive correlation between Cu with Al and Fe were observed in this fly ash particle. It proposed Cu incorporated into **spinel structure that formed $CuAl_2O_4$ and $CuFe_2O_4$**. Copper immobilization can be accomplished by stabilizing copper into spinel structure.

Conclusion

- This study estimated the metal association of MSWI fly ash generated in a fluidized bed type combustor in Japan by using micro-scale correlation analysis. In metal association analysis, **individual cross-section profile** data of fly ash particles measured by elemental mapping using SEM-EDX that could detect as **crystalline and non-crystalline metal species**.
- **The crystalline and non-crystalline of Cr and Cu were incorporated into spinel structure** in the fly ash particle. These metals also **incorporated in Al/Ca/Si-based core component** of fly ash particles. It suggested chromium and copper is not easily to leached out from fly ash particle because these metals entrapped into spinel structures and Al/Ca/Si-based core fly ash.