Sound Recycling System for Fly Ash from Municipal Solid Waste Incinerator to Be Raw Material in Cement Industry —The Study of Calcinating Process of Washed Fly Ash—

Fenfen ZHU *, Masaki TAKAOKA, Kenji SHIOTA, Kazuyuki Oshita, Yoshinori KITAJIMA, Shinsuke MORISAWA

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Kyoto University The Graduate School of Engineering

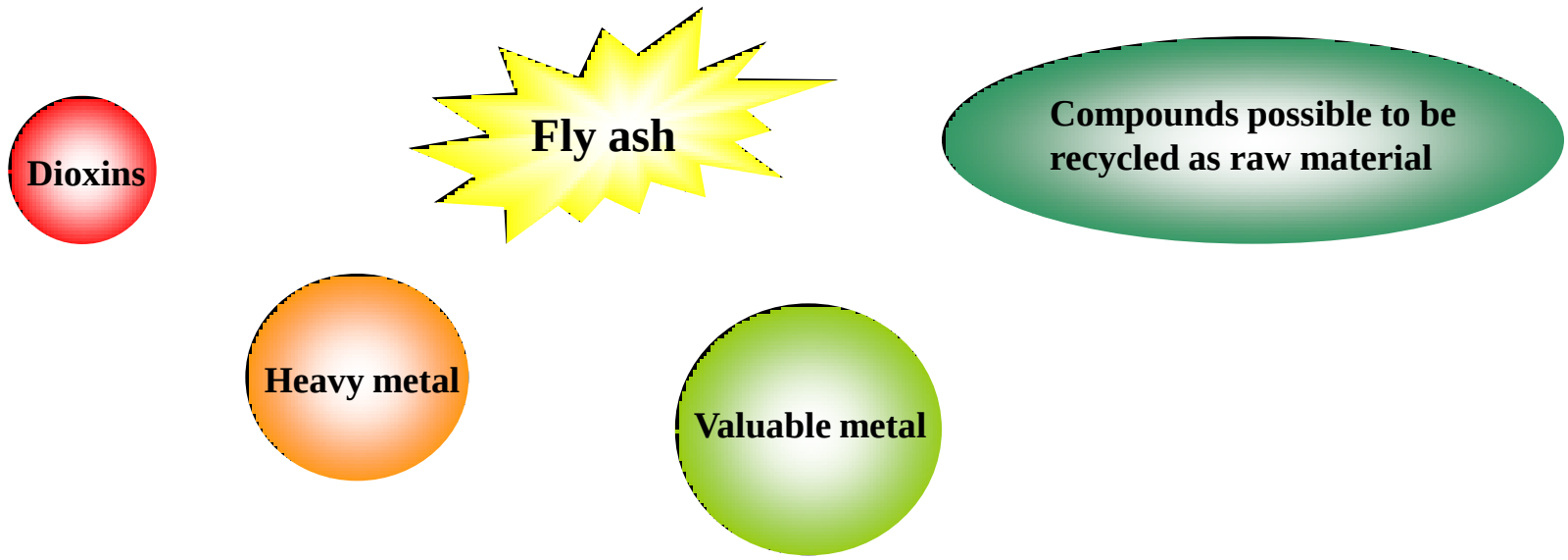
Urban and Environmental Engineering

OUTLINE

- **Introduction**
- **Experiment Material and Methodology**
- **Results and Discussions**
- **Conclusions**

INTRODUCTION

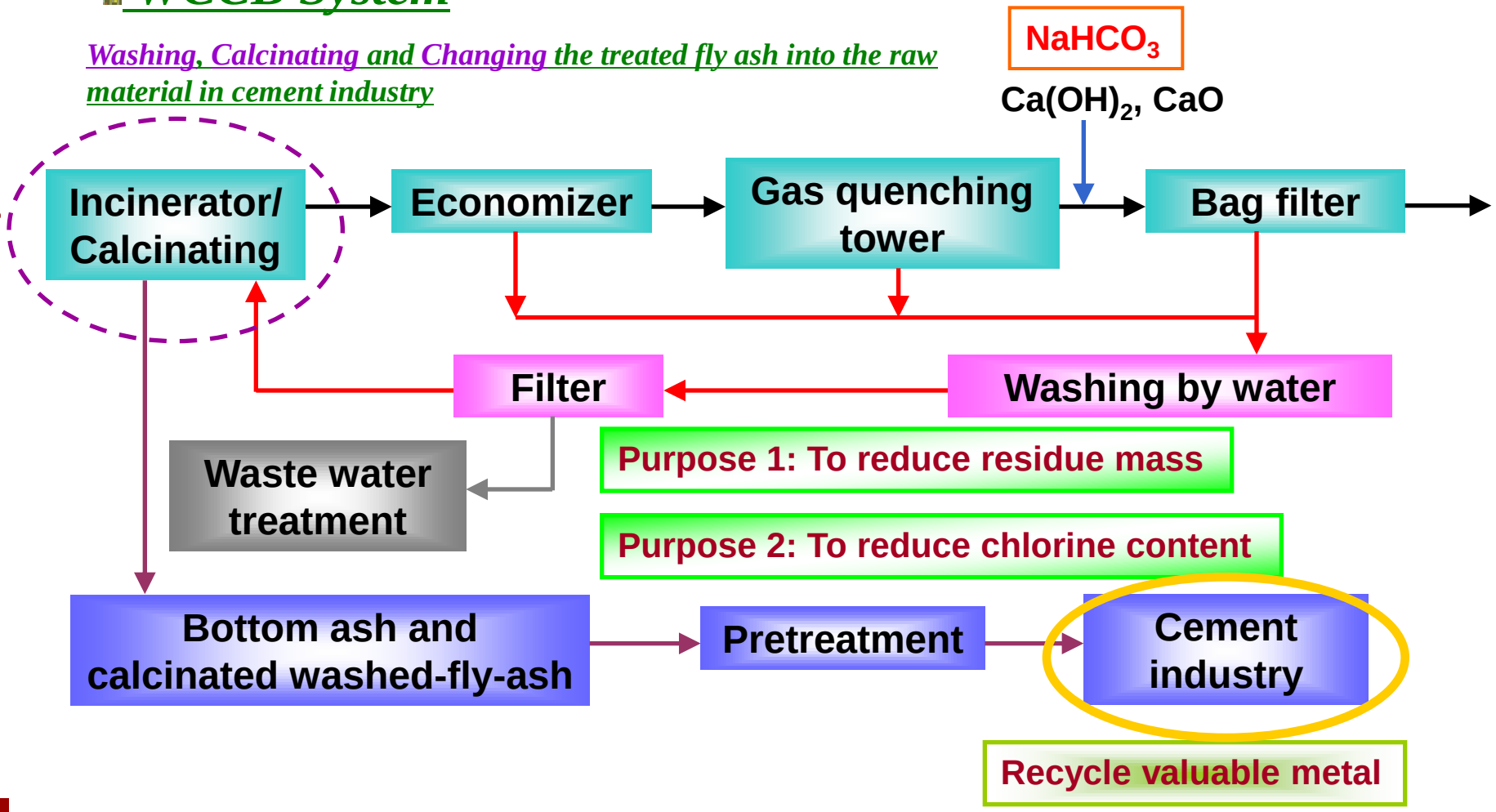
- **In year 2006, more than 38 million tons of municipal solid waste were incinerated in Japan, which should lead to 0.76~1.9 million tons of fly ash.**



INTRODUCTION

WCCB System

Washing, Calcinating and Changing the treated fly ash into the raw material in cement industry



INTRODUCTION

- **Purpose of this research**
  - **Mass flow during washing and calcinating process**
  - **Mechanism happened in calcinating process, especially the chlorides behavior**

EXPERIMENTAL MATERIAL AND METHODOLOGY

- **Experimental Material**
  - ***RFA***
    - **raw fly ash from the boiler of incinerator, Cl%=6.81%**
  - ***CaFA***
    - **fly ash collected by bag filter with the injection of calcium hydroxide for acid gas removal, Cl%=16.2%**
  - ***NaFA***
    - **fly ash collected by bag filter with the injection of sodium bicarbonate for acid gas removal, Cl%=33.9%**
  - ***RFA-II#, CaFA-II#, NaFA-II#***
    - **Washed fly ash would be the material for calcinating process**

EXPERIMENTAL MATERIAL AND METHODOLOGY

- **The former research**
  - **Washing process**
    - **Final condition: two-step washing (L/S=3, Mixing time=5 minutes, Mixing speed=150 rpm; L/S=3, Mixing time=10 minutes, Mixing speed=150 rpm) (Zhu et al, *WM*, 2009)**
    - **Chlorides behavior during the washing process (Zhu et al, *ES&T*, 2008; Zhu et al, *J. of Air&WM Asso.*, 2009)**
  - **Calcinating process**

	Heating Temperature (℃)	Heating time (hr)	Dwell time (hr)	Atmosphere	Flux (ml/min)
G(1)	400, 500, 600, 700, 800, 900, 1000, 1100	1	1	100% N_2	25
G(II)	1000	1	1	10% O_2 (90% N_2)	25, 50, 75
G(III)	1000	1	0.5	10% O_2 (90% N_2)	50

- **Final condition chosen: Heating temperature=1000℃, Atmosphere is 10% O_2 (90% N_2), Flux= 50 ml/min**

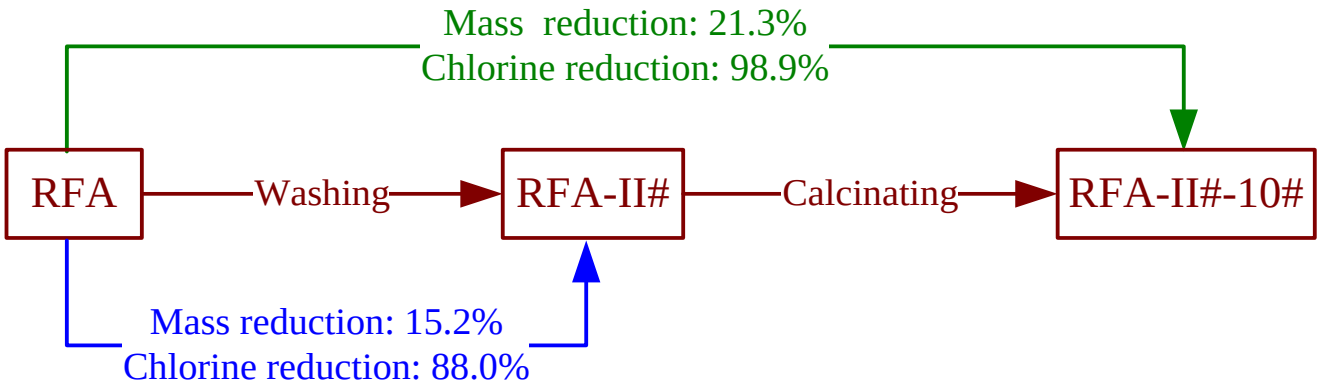
EXPERIMENTAL MATERIAL AND METHODOLOGY

- **Experimental Methodology**
  - **X-ray Diffraction (XRD)**
    - **Crystal compounds**
  - **X-ray Absorption Near Edge Structure (XANES)**
    - **Compounds of low concentration**
    - **Existing chemical form and possible distribution**

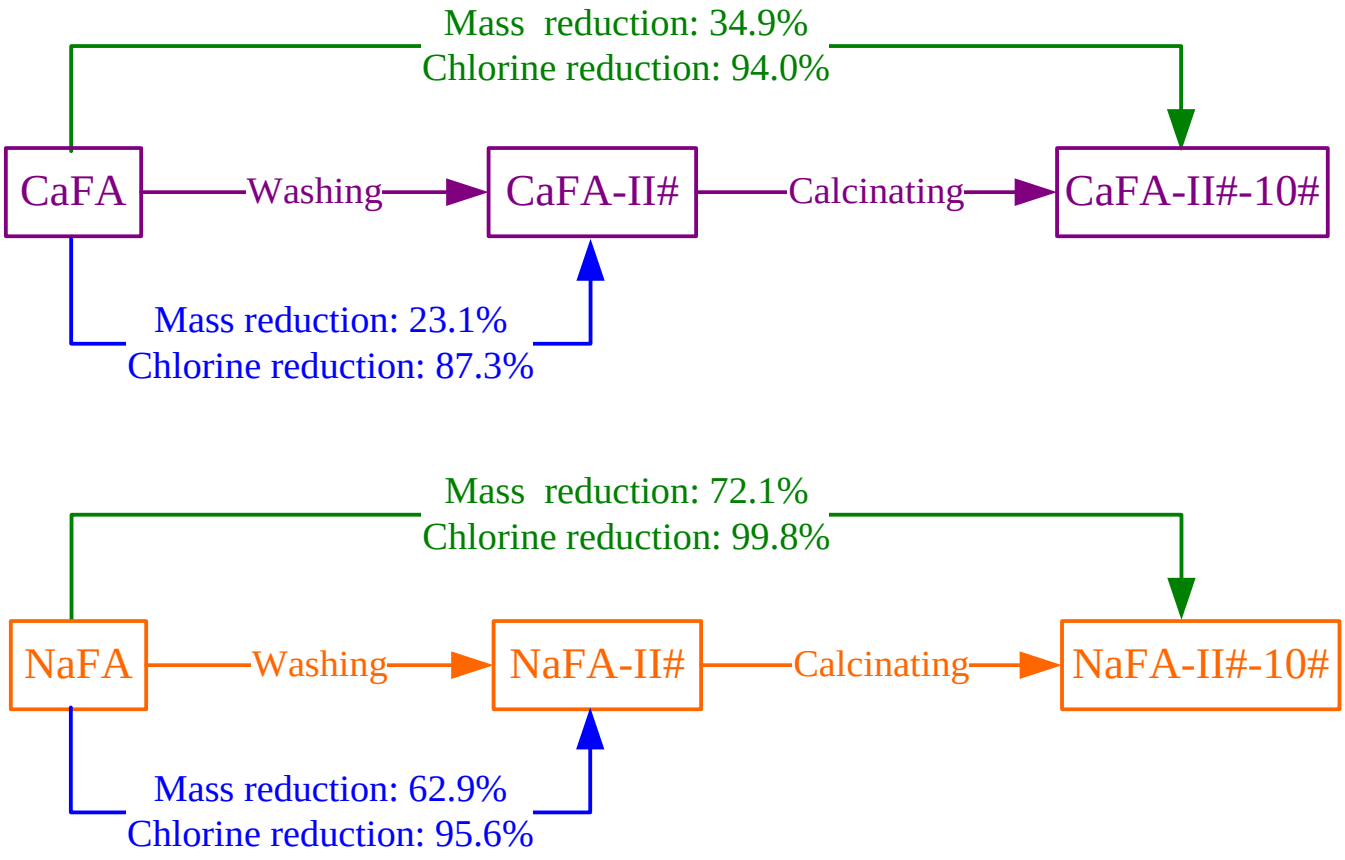
RESULTS AND DISCUSSIONS

- **Mass flow**
  - **Mass reduction:** $\frac{M_{original} - M_{final}}{M_{original}} \times 100\%$
  - **Chlorine reduction:**

$$\frac{M_{original} \cdot C_{Chlorine,original} - M_{final} \cdot C_{Chlorine,original}}{M_{original} \cdot C_{Chlorine,original}} \times 100\%$$



RESULTS AND DISCUSSIONS



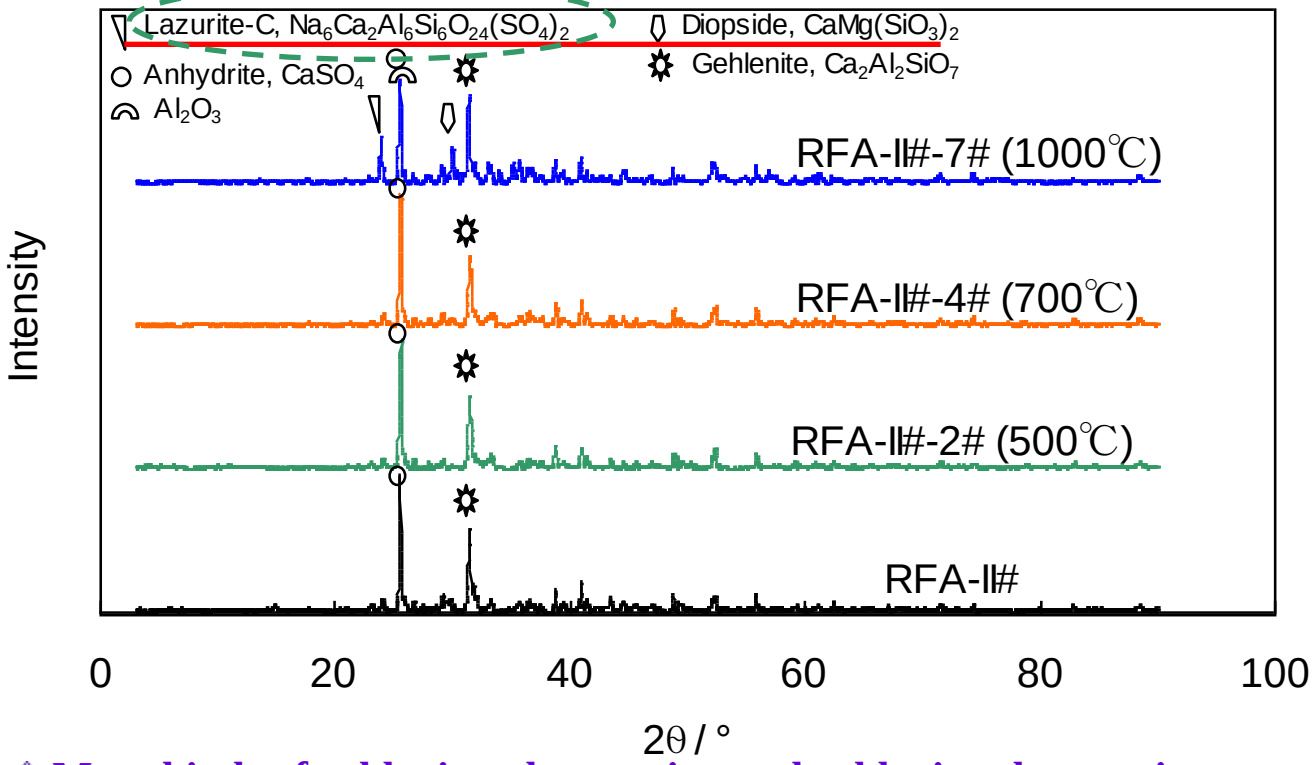
Under the same condition, NaFA has much less amount of residue and chlorine left than CaFA

RESULTS AND DISCUSSIONS

- **XRD Results (RFA-II# as example)**

◆ **New structures were formed**

$Na_6Ca_2Al_6Si_6O_{24}$ SO_4, S, Cl $_2$

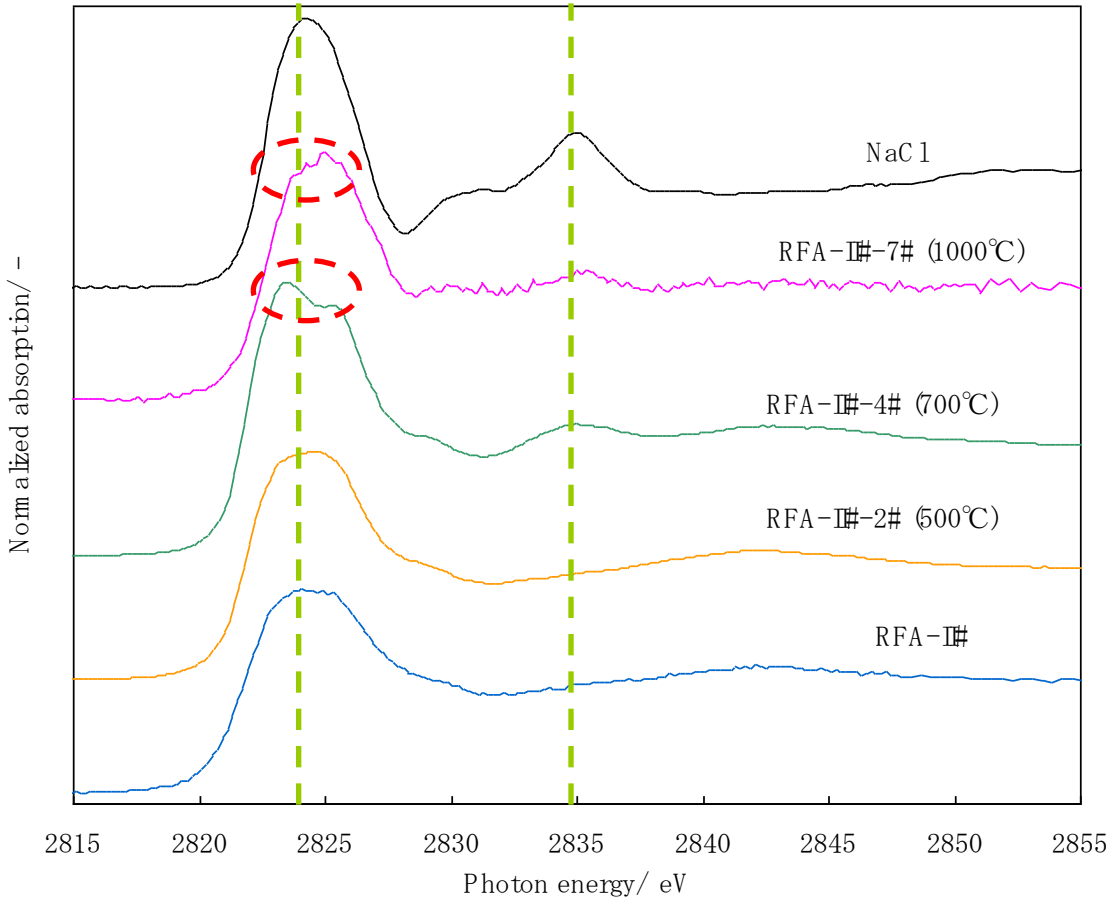


◆ **More kinds of gehlenite, akermanite, and gehlenite-akermanite**

$(Ca_{0.97}Zn_{0.03})_2(Al_{0.63}Zn_{0.37})(Si_{0.69}Al_{0.31})_2O_7$ $(Ca_{1.96}Na_{0.05})(Mg_{0.24}Al_{0.64}Fe_{0.12})(Si_{1.39}Al_{0.61}O_7)$

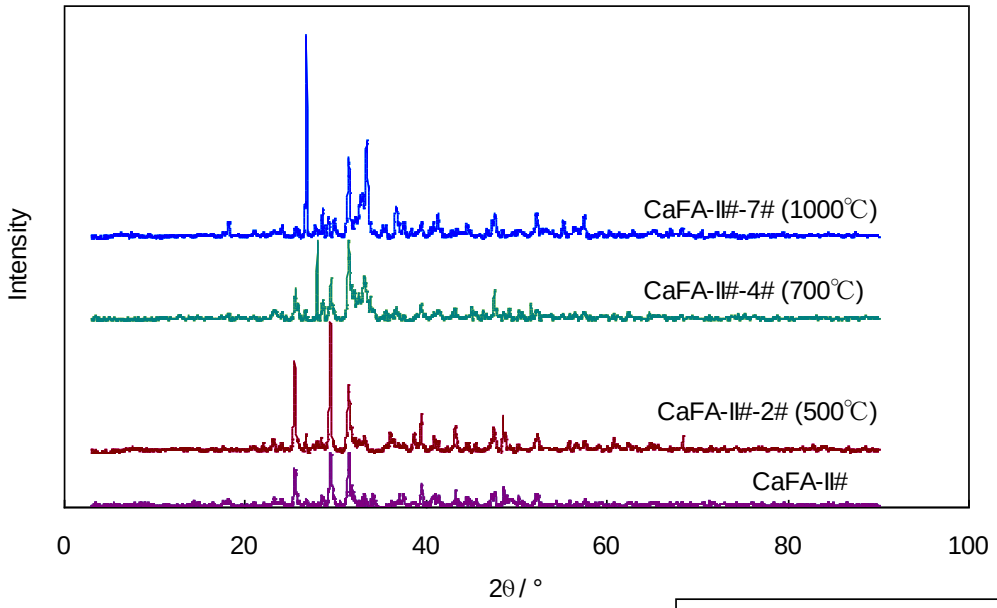
RESULTS AND DISCUSSIONS

- **Chlorine K-edge XANES spectra**



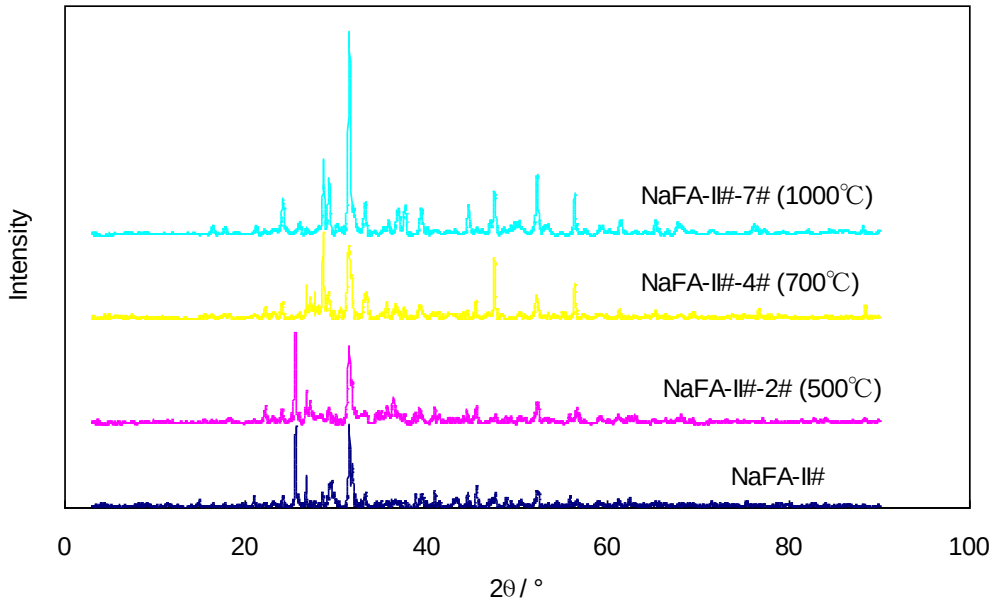
The atomic structure around chlorine atom had changed.

RESULTS AND DISCUSSION



CaFA-II#

NaFA-II#



More changes

CONCLUSIONS

- **WCCB system is effective to pre-treat fly ash for reuse in cement industry**
- **From view of mass and chlorine reduction, $NaHCO_3$ is better than $Ca(OH)_2$ to be used in the APC part of incinerator**
- **For reducing chlorine, calcinating is necessary, and during the process, more complicated compounds were produced and the atomic structure around chlorine has changed.**

Thank you very much!

XANES

- **X-ray Absorption Near Edge Structure (XANES) — Near Edge X-ray Absorption Fine Structure (NEXAFS)**