# Adsorption and removal materials of environmental pollutants utilizing wastes and unused resources

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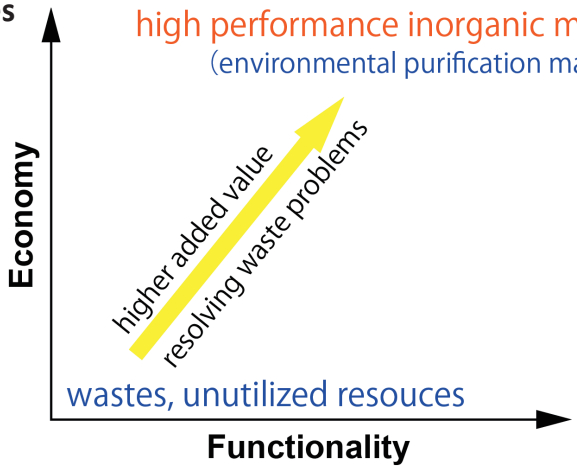
## Recycling of wastes & Utilization of unutilized resources

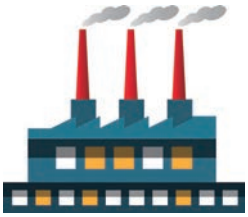
Compatible

**"Inexpensive" and "Effective"**
**environmental purification materials**

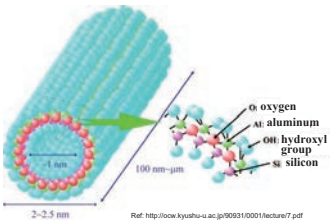
- Wastes are turned into resources by giving added values to them.
- Advanced use of low-grade or non-standard mineral resources.



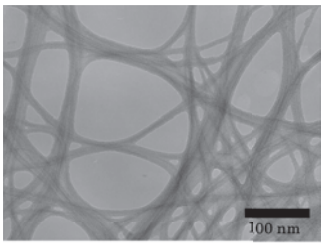

## 【Rice husk ash (RHA)】

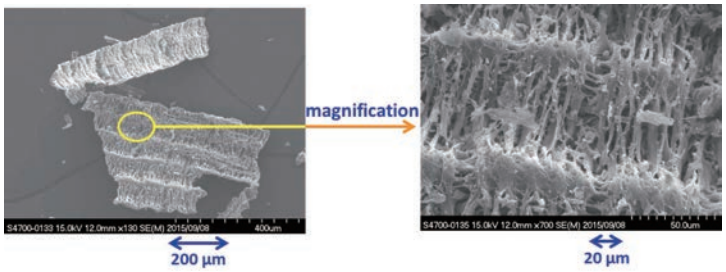


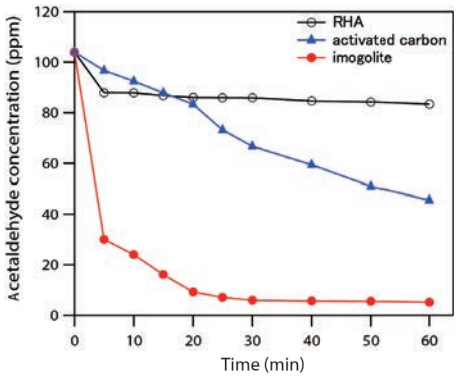
A large amount of combusted rice husk ash has been discharged from biomass power plant in southeast Asia countries!!




**conversion to high performance materials!**




Chemical composition of RHA (mass%)

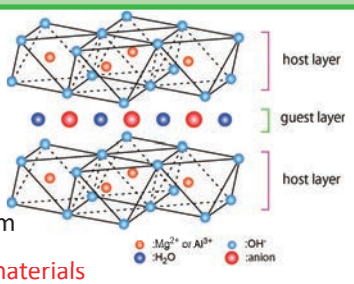
| $SiO_2$ | $Al_2O_3$ | $Na_2O$ | $K_2O$ | CaO | $TiO_2$ | MnO | $Fe_2O_3$ | MgO | $P_2O_5$ | LOI |
|---|---|---|---|---|---|---|---|---|---|---|
| 91.65 | 0.76 | 0.09 | 1.76 | 0.42 | 0.03 | 0.19 | 0.54 | 0.48 | 1.17 | 2.90 |

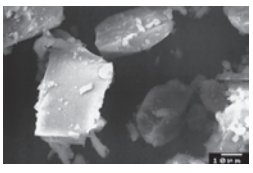
**extremely high adsorption capacity for hydrophilic VOCs！**

## 【Waste asbestos】

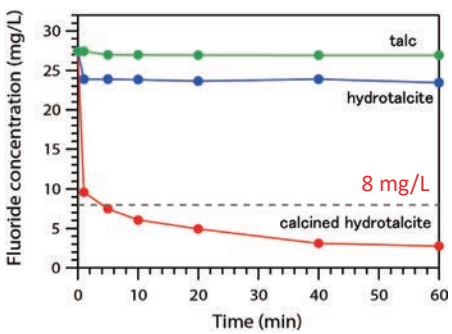
Asbestos contain lots of magnesium!!


Extraction of magnesium
&
Synthesis of anion exchange materials



**High adsorption ability for fluoride ！**



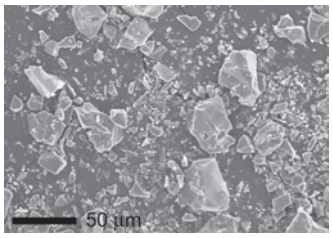

minimum effluent standard in Japan: 8 mg/L (fluoride)

serpentine group (chrysotile) : $Mg_3Si_2O_5(OH)_4$
amphibole group (amosite) : $Mg_7Si_8O_{22}(OH)_2$

## 【Blast furnace slag】

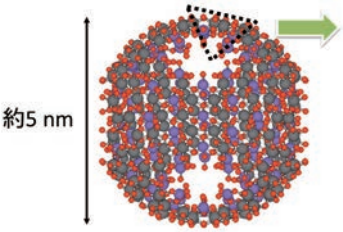
Chemical composition of blast furnace slag (mass%)

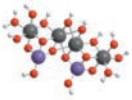
| $SiO_2$ | CaO | $Al_2O_3$ | MgO | FeO | $TiO_2$ | MnO | Total |
|---|---|---|---|---|---|---|---|
| 35.16 | 41.12 | 14.04 | 5.38 | 0.27 | 0.61 | 0.43 | 97.01 |

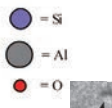


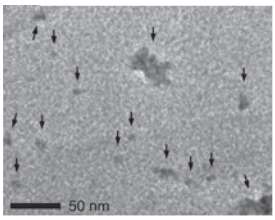

Synthesized from extracted Ca

Synthesis from Ca extraction residue



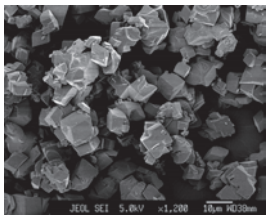





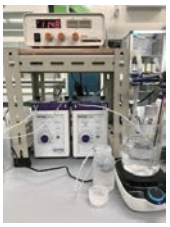

VOCs adsorbent

### High purity calcium carbonate

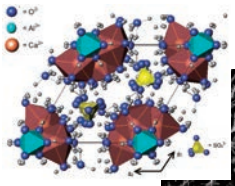


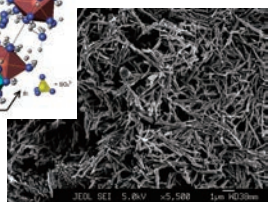
It is possible to synthesize distinctively.

mono phase: calcite
mixed phase: calcite & vaterite

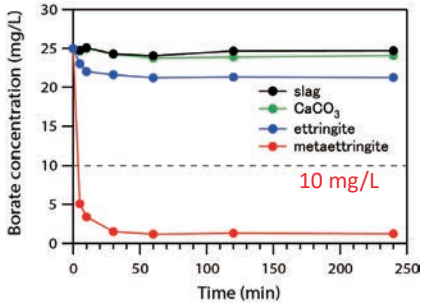


### Anion exchange material (ettringite)



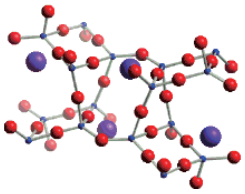


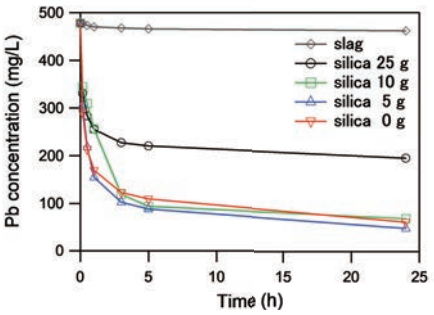
### High adsorption ability for borate




minimum effluent standard in Japan: 10 mg/L (borate)

### Conversion to heavy metal adsorbents with only alkali treatment



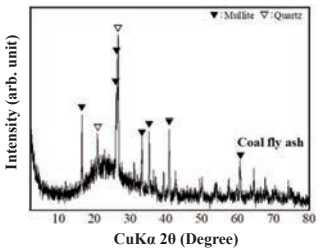


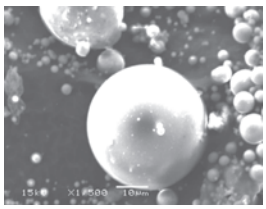

Different from conventional method, silica is unnecessary.

## 【Fly ash】

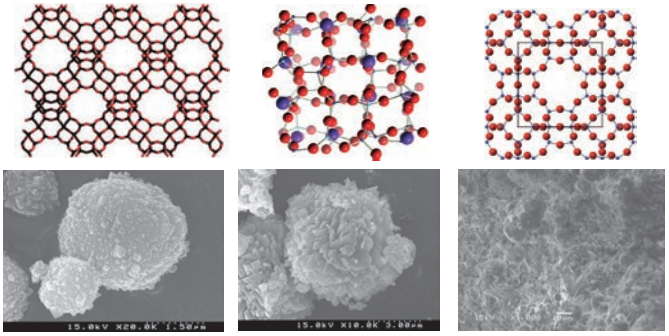
Chemical composition of fly ash (mass%)

| $Na_2O$ | MgO | $Al_2O_3$ | $SiO_2$ | $P_2O_5$ | $SO_3$ | $K_2O$ | CaO | $TiO_2$ | $Fe_2O_3$ | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.71 | 1.21 | 27.7 | 57.0 | 0.53 | 0.53 | 1.20 | 2.57 | 2.30 | 5.70 | 99.45 |



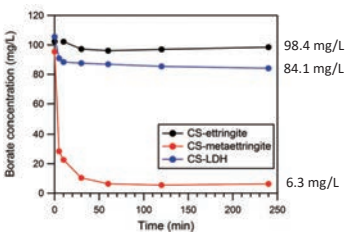
### Conversion to macroporous and mesoporous materials !

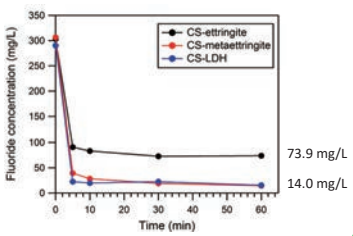


Applicable as various heavy metal and VOC adsorbents !

## 【Concrete wastes】

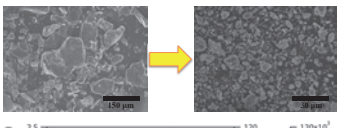
It is possible to synthesize adsorbents for oxo-anions (arsenate, chromate etc.) and heavy metals (lead etc.), and phosphorus recovery materials, using concrete waste as a raw material!

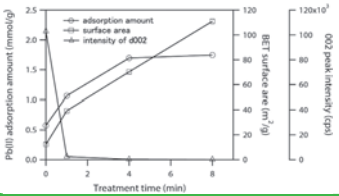


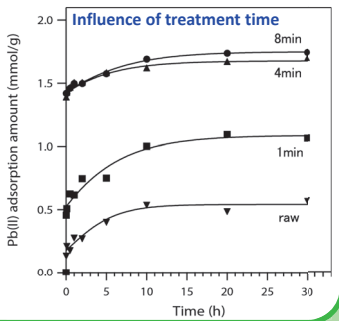




## 【Low grade minerals】

By mechanochemical treatment, the adsorption ability is dramatically improved!



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