

Ion exchange property of the layered synthetic mica with alkali and alkaline earth metal ions

Noriko SUZUKI and Yasushi KANZAKI

Showa Pharmaceutical University

3-3165 Higashi-Tamagawagakuen, Machida,
Tokyo 194-8543, Japan

There is a continuing need to develop new ion exchange materials to remove ^{137}Cs selectively from nuclear waste because nuclear electric power generation and nuclear tests have emitted a large amount of ^{137}Cs , which β -decays to ^{137}Ba , involving γ -decay. Inorganic ion exchangers are one of the promising materials for the stratum disposal of ^{137}Cs , because they have thermal stability, resistance for radiation and the higher selectivity difference among similar ions than the organic resins without any special treatment, such as chelation. One of those inorganic materials is sodium difluortetrasilicate ($\text{Na}[\text{Mg}_{2.5}\text{Si}_4\text{O}_{10}\text{F}_2] \cdot 2\text{H}_2\text{O}$: sodium type fluorotetrasilicic mica, Na-TSM) in which consist of aluminum or magnesium-oxygen octahedral sheet between silica-oxygen tetrahedral sheets (Fig.1).

Authors have already reported that Na-TSM had the highest ion exchange selectivity difference among cesium, rubidium and potassium ions.¹ The ion exchange reaction of $\text{Mg}^{2+}/\text{M}^+$ ($\text{M} = \text{Cs}^+, \text{Rb}^+, \text{K}^+$) was observed in addition to the Na^+/M^+ . Thus the ion exchange stoichiometry between $(\text{Cs}^+, \text{Rb}^+, \text{K}^+)$ and $(\text{Na}^+ + \text{Mg}^{2+})$ was established if the collapse of Na-TSM lattice was taken into consideration.

Authors expand this study on alkaline-earth metal because ^{90}Sr is another ion to be removed from the nuclear waste.

[Experimental]

A synthetic layered material, sodium difluortetrasilicate ($\text{Na}[\text{Mg}_{2.5}\text{Si}_4\text{O}_{10}\text{F}_2] \cdot 2\text{H}_2\text{O}$: Na-TSM) was supplied from Topy Industry Co. Ltd., Japan. 10 % Na-TSM sol supplied was washed with ultra pure water for several times and the precipitated powder was filtered and dried.² Ion exchange reaction was carried out by the batch method. An atomic absorption spectrophotometer, abbreviated as AAS (HITACHI 170-30, Hitachi, Ltd., Japan), was used to determine alkali metal ions. An inductively coupled plasma atomic emission spectrometer, abbreviated as ICP (SHIMADZU ICPS-5000, Shimadzu Corp., Japan), was used to determine alkaline-earth metal ions. A powder X-ray diffractometer (MO3X-HF, MAC Science Co., Ltd., Japan) equipped with mono-chromized Cr-K α and Cu-K α radiations, $\lambda=0.2896$ nm and $\lambda=0.1541$ nm, respectively, was used to characterize the layered materials before and after the ion exchange reaction.

[Results and Discussion]

Figure 2 shows the K_d values of alkaline-earth metal ions on Na-TSM. No significant ion exchange selectivity difference was observed between calcium and strontium ions since they have high K_d values, especially at low concentration. On the other hand, magnesium ion was hardly ion-exchanged on Na-TSM as shown in Fig. 1. This phenomenon could be explained if the ion exchange reaction is occurred with magnesium ions as same as alkali metal ions.

Table 1 summarizes the amount of Mg^{2+} , which was released from Na-TSM during the ion exchange reaction with the amount of sorbed Ca^{2+} or Sr^{2+} . Small amount of Mg^{2+} (3.72×10^{-6} mol g^{-1} TSM) was released in the blank test. It is clear that about half amount of sorbed Ca^{2+} or Sr^{2+} was ion-exchanged with Mg^{2+} in every case.

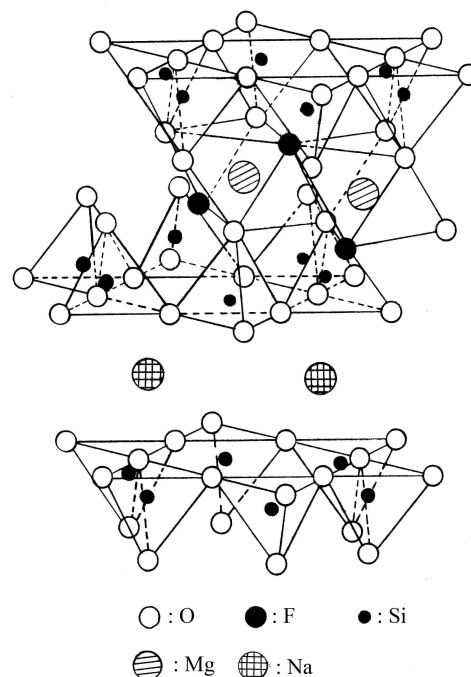


Fig. 1 The Schematic Model of Na-TSM.

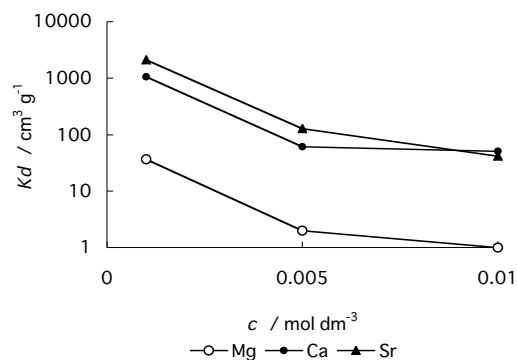


Fig. 2 K_d values of alkaline-earth metal ions on Na-TSM.

Table 1 Amount of sorbed or released metal ions.

Concentration of metal ion / mol dm^{-3}	Amount of sorbed ion / $\times 10^{-4}$ mol g^{-1} TSM	Amount of released Mg^{2+} / $\times 10^{-4}$ mol g^{-1} TSM
Ca^{2+}	1×10^{-3}	7.71
	5×10^{-3}	21.6
	1×10^{-2}	26.2
Sr^{2+}	1×10^{-3}	8.51
	5×10^{-3}	24.3
	1×10^{-2}	26.5

REFERENCES

- N. Suzuki et. al., *Bull. Chem. Soc. Jpn.*, **73**, (2000)
- Y. Kanzaki et. al., *Langmuir.*, **13**, (1997).