



HAL
open science

Influence of the Nb content and microstructure of sitinakite-type silicotitanates on Sr^{2+} and Cs^+ sorption properties

T. Milcent, A. Hertz, Y. Barré, A. Grandjean

► **To cite this version:**

T. Milcent, A. Hertz, Y. Barré, A. Grandjean. Influence of the Nb content and microstructure of sitinakite-type silicotitanates on Sr^{2+} and Cs^+ sorption properties. MNS-20 - 20202nd international conference on Materials and Nanomaterials, Jul 2020, Rome, Italy. cea-04741915

HAL Id: cea-04741915

<https://cea.hal.science/cea-04741915v1>

Submitted on 17 Oct 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Influence of the Nb content and microstructure of sitinakite-type silicotitanates on Sr²⁺ and Cs⁺ sorption properties

T. Milcent⁽¹⁾, A. Hertz⁽¹⁾, Y. Barré⁽¹⁾, A. Grandjean⁽¹⁾,

⁽¹⁾ CEA, DES, ISEC, DMRC, Univ Montpellier, Marcoule, France.
0607138178 theo.milcent@cea.fr

1. Introduction – Nuclear facilities produce radioactive effluents to be managed. These contaminated effluents contained several radionuclides including ⁹⁰Sr and ¹³⁷Cs which are among the most problematic radionuclides for environment. To ensure safe effluent management and long-term storage, the transfer of these radionuclides to a stable solid matrix is crucial. Sitinakite crystalline silicotitanates (CSTs) are known to be effective mineral ion exchangers, very selective for Cs and/or Sr depending on the pH [1] of the medium and CST chemical composition (Nb doping) [2, 3]. To better understand how CST microstructure and composition affect sorption properties, CSTs with different morphologies (consisting of micronic (Figure 1-A) to nanometric (Figure 1-B) particles) and Nb contents (from 0% to 25%) were synthesized and characterized in terms of Sr²⁺ and Cs⁺ sorption properties at moderately basic pH.

2. Experimental - After the CST synthesis and characterization by XRD, SEM and nitrogen adsorption/desorption isotherm (with BET and t-plot methods), their ion exchange properties, evaluated using Sr²⁺/Na⁺ and Cs⁺/Na⁺ equilibrium exchange diagrams, were correlated to their microstructure, morphology and composition.

3. Results and Discussion - The Sr²⁺/Na⁺ and Cs⁺/Na⁺ equilibrium exchange diagrams highlight the presence of two sorption sites with different selectivities and capacities. The first kind of site, highly selective for Sr²⁺ and less selective for Cs⁺ and at moderately basic pH, was attributed to “tunnel” sites in the CST structure. The second kind of site, less selective for Sr²⁺ and Cs⁺, seems to be a surface site [4]. Although Nb doping was found to promote Cs⁺ sorption and hinder Sr²⁺ sorption at moderately basic pH, the accessibility and selectivity of these two sites was found to depend more strongly on the microstructure of the CSTs rather than on the chemical composition. Results indicate that while the more highly crystalline, micronic particles, with fewer structural defects, the more selective for Sr²⁺ they are, the lower specific surface areas (smaller number of surface sites) afforded by the micronic particles are associated with lower sorption capacities (compare to nanometric particles).

4. Conclusions - The data reported here show indeed that ion exchange (both Sr²⁺-Na⁺ and Cs⁺-Na⁺) in CSTs depends strongly on their microstructure (crystallinity and particle size) in a quite complex mechanism and less effectively on their chemical composition. It is therefore possible to modify the cation exchange capacities as well as their selectivity for a given ion just by modifying the microstructure and the composition of the CST. This result is therefore interesting to adjust CST sorbent properties, depending on the composition of the effluent that need to be treated.

5. References

1. Anthony, R.G., et al., *Use of silicotitanates for removing cesium and strontium from defense waste*. Industrial & Engineering Chemistry Research, 1994. **33**(11): p. 2702-2705.
2. Luca, V., et al., *Nb-substitution and Cs⁺ ion-exchange in the titanosilicate sitinakite*. Microporous and Mesoporous Materials, 2002. **55**(1): p. 1-13.
3. Tripathi, A., et al., *Selectivity for Cs and Sr in Nb-substituted titanosilicate with sitinakite topology*. Journal of Solid State Chemistry, 2003. **175**(1): p. 72-83.
4. Perovskiy, I.A., et al., *Sorption of multivalent cations on titanosilicate obtained from natural raw materials. The mechanism and thermodynamics of sorption*. Microporous and Mesoporous Materials, 2021. **311**: p. 110716.

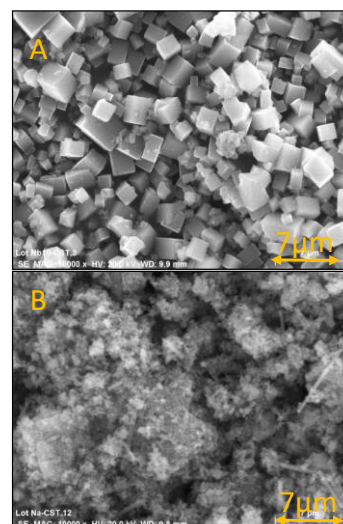


Figure 1. A: Micronic CST;
B: Nanometric CST