The Interactions of Selenium Oxyanions on the Binary Oxide Systems

Ya-Ting Chan (詹雅婷)[1], Wen-Hui Kuan (官文惠)[2], Tsan-Yao Chen (陳燦耀)[3], Ming-Kuang Wang (王明光)[1], Jyh-Fu Lee (李志甫)[4], and Ling-Yun Jang (張凌雲)[4]

[1]Department of Agricultural Chemistry, National Taiwan University, Taipei, Taiwan
[2]Department of Environmental and Safety Engineering, Ming-Chi Institute of Technology, Taipei, Taiwan
[3]Department of Engineering and System Science, National Tsing Hua University, Hsinchu, Taiwan
[4]National Synchrotron Radiation Research Center, Hsinchu, Taiwan

The binary oxide systems of Al(III) or Fe(III) mixed with X-ray noncrystalline SiO_2 were prepared at different pH values. The objectives of this study were to understand the interaction between selenium oxyanions and the adsorbents. The discrete $Fe(OH)_3$ particles formed on the surface of SiO_2 because of the hydrolysis rate of iron oxide, whereas Al(III) hydrolysis and surface hydroxide precipitation must be invoked with SiO_2 as pH progressively increase [1][2]. According the results, we know Al change the surface of SiO_2, and we have to discuss the difference of Al(III)/SiO_2 and Fe(III)/SiO_2.

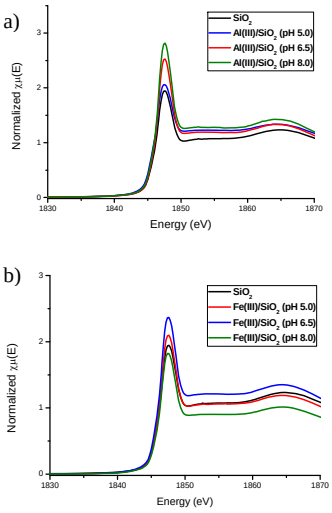

Fig. 1: XANES signal for a) Al(III)/$SiO_{2(s)}$ and b) Fe(III)/$SiO_{2(s)}$ prepared at different pHs, respectively. The center atom is silicon (K-edge = 1839 eV).

According to XANES of the binary oxide systems (Fig. 1a), the hybridization of Al(III) on SiO_2 increased as pH increasing, and it suggested that Al(III) formed a surface complexation with SiO_2. However, Fe(III) did not hybrid with SiO_2 (Fig. 1b), and Fe(III) formed discrete particles to be adsorbed on SiO_2. Therefore, the zeta potential of Fe(III)/SiO_2 is less than Al(III)/SiO_2 [1]. The surface charge of the binary oxide systems affected the selenium adsorption capacity but not complexation structures. Selenite on Al(III)/SiO_2 and Fe(III)/SiO_2 forms inner-sphere complexes, including bidentate and monodentate ones, respectively (Fig. 2). However, selenate on Al(III)/SiO_2 forms weaker inner-sphere monodentate complexes, the same as selenate on Fe(III)/SiO_2 (Fig. 3) [3][4][5].

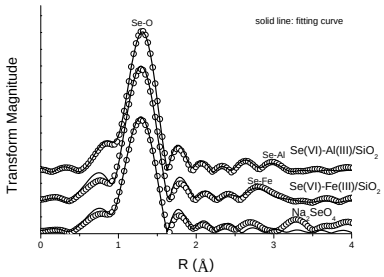

Fig. 2: RSF profiles of EXAFS signal for selenium species standard, and selenite sorbed on the binary oxide systems at pH 5.0. Solid lines and open circles represent fitted and experimental data, respectively.

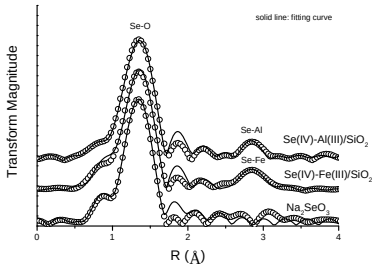

Fig. 3: RSF profiles of EXAFS signal for selenium species standard, and selenate sorbed on the binary oxide systems at pH 5.0. Solid lines and open circles represent fitted and experimental data, respectively.

References

[1] X. Meng and R. D. Letterman, Environ. Sci. Technol. **27**, 970 (1993).
[2] W. H. Kuan, S. L. Lo, and M. K. Wang, J. Colloid Interface Sci. **272**, 489 (2004).
[3] A. Manceau and L. Charlet, J. Colloid Interface Sci. **168**, 87 (1994).
[4] D. Peak, J. Colloid Interface Sci. **303**, 337 (2006).
[5] D. Peak, U. K. Saha, and P. M Huang, Soil Sci. Soc. Am. J. **70**, 192 (2006).