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# Chemical state of Fe in urban atmospheric aerosol particles in Fukuoka, Japan

Chiharu Nishita-Hara[1], Masashi Kogawa[1], Satoshi Utsunomiya[1*]

[1]Dept. Chemistry, Kyushu Univ.

Iron is the most common transition metal in atmospheric aerosol particles and plays important roles in atmospheric chemistry and biological processes. In this study, chemical state of Fe, such as speciation and elemental mixing state, has been investigated in detail by multi-scale (nano to bulk) analytical techniques for urban atmospheric aerosol particles. The sample particles were collected using a 9-stage cascade impactor at an urban back ground site (Hakozaki campus of Kyushu University) in Fukuoka, Japan from 25 October to 31 October 2009. For super-micron particles (1 -8 micron diameter), elemental mixing state of Fe was investigated by individual particle analysis using a scanning electron microscopy/energy dispersive X-ray (SEM-EDS). Iron was detected in about 40 % of the super-micron particles. Almost all ( >99 %) of the Fe-including super-micron particles were composed mainly of Si and Al, and atomic ratio of Fe to all detectable elements were smaller than 20 % (about 6 % on average) in these particles. However, elemental map by a scanning transmission electron microscopy (STEM) reveals that Fe distribution in each individual particle have a wide variation. In some particles, Fe distribution differed from that of Al and Si. In these particles, Fe might be present as iron oxide particles sticking to aluminosilicate in these particles. In the other particles, Fe distribution is identical to that of Al and Si, which indicates that Fe is contained in Fe-bearing aluminosilicate (e.g., biotite and chlorite). Synchrotron-based X-ray absorption near-edge structure (XANES) at Fe K-edge indicates that major speciation of Fe in the super-micron particles is $Fe_2O_3$. Mixing state of Fe was also investigated for submicron particles (0.06-1 micron diameter) using STEM. In this size range, Fe is associated with Mn forming an aggregate of small (approximately 50 nm in diameter) roughly-spherical particles, which was not observed in the super-micron size range. XANES at Fe K-edge reveals that major speciation of Fe in the submicron particles is $Fe_2O_3$, which is the same to the super-micron particles. However, in terms of particle shape and elemental mixing state, Fe-bearing particles in the super-micron and submicron size ranges were different. These differences can result in the particle-size dependencies of catalytic effects and bioavailability of Fe in aerosol particles.

Keywords: ultra-fine particle, TEM, nano