Structural analysis of fine particles using a Time-of-Flight Secondary Ion Mass Spectrometer

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Keywords: Q-AMS, Fukue, long-range transport
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Rapid development in East Asian countries has brought the increase of emission of atmospheric pollutants (Ohara *et al.*, 2007). Gas and aerosol are transported from the Asian continent to the Pacific Ocean in the winter-spring by seasonal monsoon. Since the mixing state and chemical transformation of aerosol particles influence direct radiative forcing (Adachi *et al.*, 2010), individual particle analysis is important. Individual particles have been analyzed by electron probe microanalysis (EPMA) (Tomiyasu *et al.*, 1996), scanning electron microscopy (SEM) (Ault *et al.*, 2012) and transmission electron microscopy (TEM) (Adachi *et al.*, 2010). Recently, time-of-flight secondary ion mass spectrometry (TOF-SIMS) has been introduced to study the structure of aerosol particles (Sakamoto *et al.*, 2008). The TOF-SIMS can analyze the materials located inside the particles by the combination of FIB milling and repeated elemental mapping. We show the structure and chemical composition of fine aerosol particles with diameters of 1 μm collected in the East Asian region.

Sampling was performed at the National Institute of Environmental Studies (NIES) Fukue Atmospheric Observation site (Fukue site; 128.7E, 32.8N) in spring 2011. An Aerodyne quadrupole aerosol mass spectrometer (Q-AMS) was used for the continuous chemical analysis of aerosol. The TOF-SIMS sample was collected on the silicon substrate and was sent to Tokyo for the TOF-SIMS analysis.

Comparison of the Q-AMS measurement results with those of previous studies made at the same location (Takami *et al.* 2005) were similar, suggesting that the particle composition we observed is typical for this site.

Based on the results of TOF-SIMS, we classified the aerosol particles into three types: Type A, sulfate covered with Organic Matter (OM); Type B, soil-containing particles covered by sulfate and OM; Type C, BC and sulfate aggregates covered by OM (see Figure 1). As for Type B, soil was found inside the sulfate and OM was found on the outer surface. In Type C, BC was found at the edge and/or the surface of the sulfate, and formed BC-sulfate aggregates.

During the observation period, the relative abundances of Type A, B, and C particles were 55%, 20%, and 25%, respectively, while in Tokyo, they were 60%, 35%, and 5% (Table 1). More than half of the fine particles were light scattering, in Fukue and Tokyo. These results can be used for the revision and/or constraints of regional and global simulation for the radiative forcing.

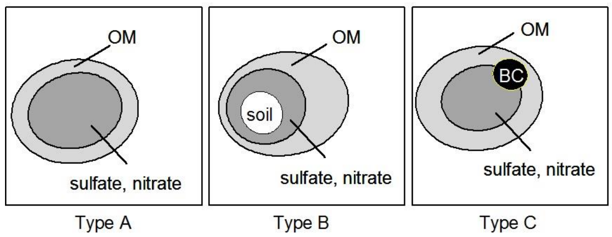

Figure 1 Schematics of the structures of fine particles of Types A to C

Table 1. The relative abundances of each type

	Type A (%)	Type B (%)	Type C(%)
Fukue	55	20	25
Tokyo	60	35	5

We greatly appreciate the support from GERF (B-1006, A-1101), MEXT-Shingakujutsu (ASEPH), and JST-SIRCP

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