

Biomonitoring of atmospheric particles using roadside trees leaves: micro-PIXE and SEM-EDX analysis of leaves

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CREATIVE & FULL KNOWLEDGE

In order to shed light on the problem of atmospheric particles pollution of roadside in megacities area, we carried out two-dimensional elemental analysis of roadside trees leaves by using micro-PIXE, while morphological and elemental characterizations of the atmospheric particles retained on the leaves surface were analyzed by using SEM-EDX.

The roadside trees leaves were collected at Imazato crossing in Osaka megacity area and Kamiuma crossing in Tokyo metropolitan area, Japan (Figures 1 & 2). Both crossings have serious problems of air pollution caused by heavy traffic.

The sample at Imazato is Keyaki (*Zelkova serrate*) leaves, and the sample at Kamiuma is ginkgo (*Ginkgo biloba*) leaves. Both species are deciduous broad-leaves trees and very popular as roadside trees in Japan. The leaves were collected three times of spring, summer, and autumn in 2013. The sampling of first time is approximately three weeks after foliation in April, the second time is in August, and third time is before the natural leaf fall in November.



Figure 1 Location of the sampling sites.



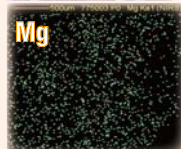
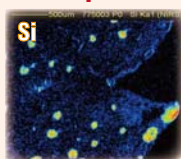
Figure 2 Photograph of the sampling sites.

In micro-PIXE analysis, nineteen elements were detected in total. Maps of Si and Mg are shown in Figure 3. In the case of Imazato, patchy Si may have been atmospheric particles that stuck to the leaf. Silica is one of the major elements of atmospheric particles. For Kamiuma, finding the patchy Si is difficult. Magnesium is one of the elements which plays a key role for the plant photosynthesis, and was observed widely in all the leaves.

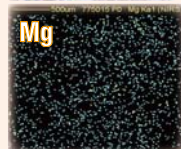
Typical SEM images of leaf samples are shown in Figure 4. Small spherical particles, aggregates of particles, and cubic particles were observed on the samples using the SEM, and X-ray analysis of the particles was conducted by the EDX. The small spherical particles were the silicon-rich type. Silicon-rich spherical particles generated in coal-fired power plants have diameters in the range 0.05-10 μm , and most of the particles are deposited nearby. Aggregates of particles are made of elemental carbon, *i.e.* car exhaust. Cubic particles are the silicon-rich and the aluminum-rich type, *i.e.* soil particles and/or road dust.

Imazato

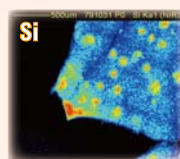
April



August

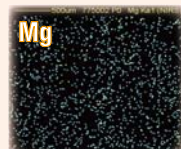


November



Kamiuma

April



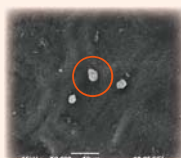
August



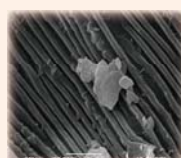
November



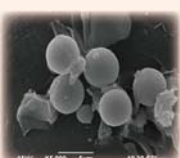
Figure 3 Si and Mg maps of roadside trees leaves.



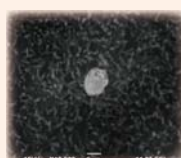
Al+Si mainly single particle



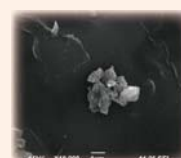
Aggregates of C-based particles



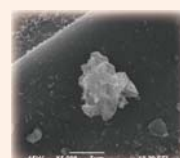
Si-based single particle (Fry ash)



Aggregates of S+Ca mainly particle



Aggregates of Si-based particles



Aggregates of C-based particles

Figure 4 Typical SEM images of particles on roadside trees leaves.

The research results are important for the physicochemical characterization of particles in atmospheric roadside, enabling detailed analysis of the various roadside emission sources and atmospheric processes.

In Japan the concentration of air pollution is observed by using automatic monitors. However, observation by the monitors is difficult in crossing and power non supply area. Therefore, monitoring on atmospheric particles using leaves sample, *i.e.* biomonitoring is considered a useful technique to evaluate the air pollution.