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Air pollution studied by Mossbauer spectroscopy and synchrotron

Air pollution is focused upon strongly nowadays because many diseases are caused by inhaled particulate matter (PM) in air such as pulmonary and trachea diseases as well as epidemiological diseases. The toxicity of PM to human health is not only related to its elemental concentration and particle size also to its chemical species. Mossbauer spectroscopy can be used to study those information from Fe[1] .Besides Fe, Pb, Zn, Cu and Mn etc. were studied by XANES on Synchrotron[1]. In order to control the pollution to find the origin of pollution sources is also important. The synchrotron X-ray fluorescence microprobe (μ-SXRF) is a powerful tool to study that by analysis of individual aerosol particles combined with the pattern recognition technique[2].

In this paper we present the study of speciation of iron and its transformation in atmospheric particulate matter in Shanghai. The samples of PM10 (aerodynamic diameter<10μm) and PM2.5 were collected from four sampling sites in Shanghai, China. They represent the iron and steel industrial district, commercial district and suburban district, respectively, as well as a special place i.e. tunnel where only for vehicles. The components of iron were determined by a least squares fitting of Mossbauer spectra. The iron concentrations were determined by ICP-MS.

The results showed that iron compounds in all samples consisted of Fe2O3, Fe3O4 , Fe2(SO4)3 and Fe2+ high spin state but their proportions were different in different sampling sites, dependent of each environmental condition. The relative concentration of iron oxide in samples collected in the iron and steel industrial district is higher than the one in commercial and suburban districts, but the relative concentration of the iron sulfate is contrary to that case. In addition it was found that the concentrations of ferric sulfate in PM2.5 are higher than those in PM10. In order to study the transformation of iron compound the samples collected from different position in tunnel, i.e. middle, entrance of tunnel and 500 m away from tunnel, were measured. The transformation of Fe3O4 to Fe2O3 was found. Moreover it was found that SO2 in air plays an important role for the transformation of iron oxide to iron sulfate. Many of iron's results were proved by XANES. Meanwhile other elemental speciation in PM is also presented, for instance Pb, Zn, Cu, and Mn.

In addition it was interestly found by Mossbauer spectroscopy at low temperature (12 K) that a big amount of superparamagnetic particles with ~10 nm contained in PM, and their relative concentrations were related to the sampling sites. These nano-particles can reach alveoli directly, leading to high toxicity to human health.

The result of pollution source assignment shows that the most of analyzed PM10 and PM2.5 particles were derived from vehicle exhaust, metallurgic emissions and power plants. The change of their relative contribution and the decreasing of mass concentration with year were also found.

References

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Summary

Mossbauer spectroscopy and synchrotron are powerful tools for studying the air pollution. Based on the study we got the mass concentration, elemental chemical speciation in particulate matter in air as well as their origin in Shanghai. It helps us to understand the pollution characteristic and to find a way how to control air pollution in Shanghai.

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