Development of a portable PIXE system for aerosol monitoring

S.Matsuyama, K.Ishii, D.Izukawa, H.Yamazaki, Ts.Amartaivan, K.Hotta, [1)]S.Futatsugawa [2)]K.Sera

Department of Quantum Science and Energy Engineering
Tohoku University, Sendai 980-8579, Japan

[1)]Nishina Memorial Cyclotron Center, Japan Radioisotope Association
Takizawa, Iwate 020-0173, Japan

[2)]Cyclotron Research Center, Iwate Medical University
Takizawa, Iwate 020-0173, Japan

Abstract

Elemental concentrations in atmospheric aerosol reflect air pollution and its generating process. Therefore, elemental analysis of atmospheric aerosols can lead to the identification of the kind of aerosol sources. In a previous study, we demonstrated that the multi-site sampling system combined with meteorological data is well suited to identify sources of pollution. However, this method uses two steps, aerosol site sampling and PIXE analysis, the latter requiring a particle accelerator mostly far away from sampling sites. It is preferable to perform sampling and elemental analysis simultaneously (in-situ). Therefore we developed a portable PIXE, which can be carried anywhere outside of radiation controlled area. This portable PIXE should then be incorporated into the mini-step sampler. The portable PIXE uses a weak ^{241}Am alpha source and a Silicon pin X-ray detector. A ring type source surrounding the detector is set parallel to the detection surface and optimization of the simulation showed that the source should be arranged forward of the detector, shielded by lead and aluminum. A ring type 49 kBq ^{241}Am alpha source was produced and the performance of this portable PIXE was checked. X-rays from thin Al, Ti, Cu, Ag, and Au foils were measured to evaluate the atomic charge dependent sensitivity. Experimental value and calculation value were practically identical for each element. The detection limit of each element was evaluated using the simulation data. It was found that the detection limits for elements Mg to Hg are a few to a few hundred □g in a typical one hour measurement. These detection limits are too high for aerosol monitoring. Therefore, a portable XRF (X-ray fluorescence), which uses a novel miniature high intensity X-ray generator (COOL-X) and a Si pin X-ray detector was investigated. To check its sensitivity, Al, Ti, Ag, and Au X-rays were measured, and the detection limits were calculated based on these results. It was found that the detection limit for Ca to Co and for Ag to Tb were one order of magnitude lower than those obtained with the portable PIXE developed in our study. We can infer that the detection limits for elements heavier than Co and heavier than Tb are also one order of magnitude lower.