X-ray Diffraction Analysis of $PM_{2.5}$ and PM_{10} Aerosols

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Particulate matter (PM) samples were sampled from a traffic site, using a low volume sampler on Teflon 47 mm diameter filters. The sampling campaign ran over a one-year period with sampling frequency of twice a week for both $PM_{2.5}$ and PM_{10}. Although X-ray diffraction (XRD) method is not commonly used in analysis of PM, we have utilized it to identify the mineral constituents of PM pollution. $PM_{2.5}$ and PM_{10} were analyzed using XRD and SEM methods. The XRD patterns of $PM_{2.5}$ revealed the existence of various mineralogical phases, which correlated with weather conditions. In the absence of winds and natural dust, secondary pollutants such as ammonium sulfate and sodium nitrates are dominant in the XRD pattern. On dusty days, ammonium sulfate was a minor phase with the coexistence of other phases such as calcite, quartz, gypsum and sodium chloride. These results can be used to identify natural and anthropogenic sources.

PM_{10} filters were also analyzed with XRD and revealed important information about various pollution constituents in this size fraction. Unlike the case for $PM_{2.5}$, natural pollution phases were dominating the XRD patterns in most samples. The commonly observed compounds were calcite, quartz, gypsum, and sodium chloride. Ammonium sulfate was also observed as a minor phase in several samples. Traffic, power plants, and industrial emissions are the major source of these secondary anthropogenic pollutants. Natural pollution sources such as desert dust, sea salts originating from sea breeze, and crustal materials are the main sources of the course size fraction of PM. XRD results for both $PM_{2.5}$ and PM_{10} were confirmed using Scanning Electron Microscopy (SEM) elemental mapping. Excellent correlation maps between various elements of each compound were observed. For example, maps of oxygen, sulfur, and nitrogen were very similar in samples that showed a major ammonium sulfate phase in the XRD pattern. This project showed that XRD is a very useful technique that can complement and confirm results obtained using XRF, the standard elemental analysis method that is usually used for PM analysis. Various pollution sources are also discussed based on the above results.