

Development of a compact, simple and precise PM2.5 sensor and its applications

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PM2.5 is the concentration of small particles floating in the air with the diameter size of less than 2.5 micrometer. The nation-wide interests about PM2.5 in Japan have increased since the PM2.5 concentration in Beijing, China became extra-ordinary high in 2013-2015. The high concentrations of PM2.5 in China influence not only the environmental conditions in China but also those in Japan through the long-range transportation across the border. The regulation for the PM2.5 concentration in Japan is defined in units of mass concentration. The upper limit values of the regulation are 15 microgram per cubic meter for one-year average and 35 microgram per cubic meter. For instruments for PM2.5 measurements, beta attenuation monitoring (BAM) and filter-based gravimetric method (TEOM) have been used in public observational stations and in environmental research stations. However, those instruments are very expensive and need accumulation time of about half a day for PM2.5 measurements. We have developed a compact and low-cost PM2.5 instrument in collaboration with Panasonic Corporation.

The new compact, palmtop PM2.5 instrument consists of a LED light source and photodiode detecting aerosol particle light scattering. To increase the precision of measurements, the sizes of individual aerosol particles are estimated from the intensities of the scattering light intensity and the PM2.5 mass concentrations are calculated. The PM2.5 measurement results for ambient air using the compact PM2.5 instrument indicated high correlation factor of > 0.8 with the results obtained by simultaneous measurement using a BAM instrument (Thermo, Sharp 5030).

Many applications of the compact, low-cost and simple PM2.5 instrument have been developed. In urban area, many instruments can be installed with high densities. Local PM2.5 sources in the urban areas can be detected with the PM2.5 instruments. 2D and 3D measurements in the atmosphere can be measured by installing the PM2.5 instruments on automobiles, drones (multicopters). Especially, the new PM2.5 instruments are suitable for the measurements in developing countries. Some of developing countries suffer from serious environmental problems of extremely high PM2.5 concentrations and their health effects. The PM2.5 observations in the developing countries have difficulty to install valuable and delicate PM2.5 instruments because of many serious difficulties about space, electric supply, dust, temperature, roof leaks, insects, safety, transportation, maintenance access, standard-gas supply and so on. The new PM2.5 instruments can be installed and operated in those conditions. The PM2.5 instruments widely distributed in high PM2.5 concentration area are suitable for epidemiological studies.

In this presentation, we will present the features of the compact PM2.5 instrument, and also present the new applications such as measurements on vehicles and in the developing countries. We have provided the measurement system which consist of a palmtop sensor and a computer with the USB cable connection. We have also provided the outdoor stand-alone system with small CPU and USB memory for year-long measurements. We will accept proposals of new applications of our compact PM2.5 instrument, and discuss the possibilities of collaborative work for the applications.

Keywords: Compact PM2.5 sensor, Instrument development, Atmospheric aerosol

