Laser-Induced Breakdown Spectroscopy for atmospheric monitoring of selected fine and ultrafine particles

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Air quality monitoring is a major challenge for this decade. One of the most important and difficult issues concerns the monitoring of fine particles (1 µm or less), and in particular ultrafine particles (100 nm or less). In mid-2018, ANSES published a report recommending strengthening the monitoring of ultrafine particles, classified as priority pollutants in the air [1]. In addition, access to the number concentration of fine and ultrafine particles of a given elementary composition is crucial for the following reasons:

- Ultrafine particles typically make up less than 1% of the mass of aerosols, but more than 80% of the total number of particles in the atmosphere.
- Ultrafine particles remain suspended in the air for a very long time, unlike micrometric particles.
- The health risks due to ultrafine particles by inhalation are high and linked to their chemical composition since they penetrate the respiratory system and can pass into the blood.

Here, we propose to discuss a method that should makes it possible to obtain the number and mass concentrations, in real time and *in situ*, of particles of a given elementary composition, without limitation in the type of particle. The size range considered is from few tens of nm to 1000 nm, covering as much as possible the domain of fine and ultrafine particles [2, 3].

The process is based on Laser-Induced Breakdown Spectroscopy (LIBS) applied to aerosols. It differs from previous works [4] by an interaction taking place under vacuum between a focused high-speed pulsed laser and a jet of particles produced by an aerodynamic lens system (SLA) [5]. The interaction with the laser therefore takes place only with the particulate phase without interaction with the gaseous phase, and continuously. The SLA makes it possible to produce a very fine and very dense jet of particles under vacuum while avoiding contamination by particle deposition of the optical elements. This deposit is indeed a major limitation of the online analysis of aerosols by optical technique.

The advantages of the presented technique compared to conventional ones at ambient pressure are:

- Zero background noise from the surrounding gas plasma.
- Highly increased sensitivity thanks to SLA concentration effect.
- Detection of individual particles, allowing counting, connected to the number concentration of particles in the air.
- More efficient detection of elements emitting in the far UV, even down to VUV.

References

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