Raman and AFM Imaging of Marine Aerosol Particles

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In many environmental applications, the characterization of particulate matter or materials having grain-like structure can be essential to understand the nature of samples. For instance, micrometric size particles in the atmosphere serve as active reaction sites for chemical reactions, thus the characterization of such individual particles can provide much more useful information about the source, reactivity, transport, and removal of atmospheric chemical species than bulk methods. Bulk methods only give the average composition of particulate samples without describing the variability of the individual particles in the sample. Today, the challenge resides in supplying analytical tools able to provide detailed knowledge on the physico-chemical composition (elemental and molecular) and the morphology of individual particles on a micrometer and nanometer scale.

In this work we present results obtained on both environmental and synthetic marine aerosol particles. Complementary to the established automated single particle analysis techniques [1], this study is focused on the use of confocal Raman microspectrometry combined with relevant self-modeling mixture analysis (Multivariate Curve Resolution) providing unique information about the molecular characterization and distribution of species within particles [2]. The atomic force microscopy (AFM) is also used as a complementary technique to describe and compare the morphology of aerosol particles after reactions with high spatial resolution (few tens of nanometers).

Environmental samples have been collected in an industrial/urban atmosphere influenced by marine air masses (trade harbor) [3]. Particles were collected at two sites upwind and downwind of intense industrial activities with PM_{10} Dekati impactors. Confocal molecular imaging together with AFM studies show a systematic agglomeration of particles emitted by the anthropogenic activities with the long-range transported sea-salt particles. This agglomeration appeared to be the major short term atmospheric event occurring during the transport of sea-salt particles.

Synthetic sea-salt particles were also prepared in laboratory following a well-known atmospheric reaction between gaseous NO_2 and NaCl crystal. The subsequent formation of $NaNO_3$ at the NaCl (100) surface is studied according to the relative humidity. Raman and AFM imaging show that the size and the morphology of nitrate particles at the NaCl surface mainly depend on the relative humidity and contribute to the knowledge of marine aerosol chemistry in troposphere.

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