CHARACTERIZATION AND REACTIVITY OF SINGLE PARTICLES - APPLICATIONS TO ATMOSPHERIC ORGANIC AEROSOLS

Dr. Sophie Sobanska

CNRS Researcher – Institut des Sciences Moléculaires ISM - Université de Bordeaux, France

The impact of atmospheric aerosols, on climate and human health is now well established and the characterization of aerosol is of prime importance to fully understand the formation and aging of aerosol particles in the atmosphere. The complex interplay of processes that govern the size, composition, phase and morphology of aerosol particles in the atmosphere is challenging to understand and model. The properties of atmospheric aerosols as well as chemical processes can be resolved at varying levels of complexity, starting with a simple measurement of size and extending through to the characterization of the composition and morphology of individual phase domains. The size and chemical composition of the aerosol can be directly interrogated by means of original Raman scattering experiments. By coupling this non-intrusive spectroscopy with levitation device, the physico-chemical processes occurring within individual particles can be probed considering in situ conditions. Thanks to the coupling of Raman scattering with atomic force microscopy, Tip-Enhanced Raman Spectroscopy (TERS) is powerful to scrutinize the surface composition of particles at the nanometer scale.

Secondary organic aerosols (SOAs) are formed and transformed through complex physico-chemical processes in the atmosphere, which lead to their complex chemical compositions. In particular, the interactions between atmospheric water vapor and aerosols play a key role in determining the observed macroscopic and microphysics properties of aerosols in the atmosphere. The complexity of the chemical composition of collected SOA particles requires some experiments on model particles to define pros-and-cons of advanced analytical methodologies.

Here, we will present, as an example, the characterization of individual SOA particles using TERS. The TERS measurements were achieved using a bottom-illumination TERS instrument. The conventional Raman imaging performed on the submicronic fraction of particles only lead to the identification of inorganic species such as nitrate and sulphate-rich particles. TERS features highlighted the mixed organic/inorganic composition of nanosized particles and TERS images clearly shown the heterogeneous distribution of oxygenated organic compounds within particles. Additionally, the dark-field Rayleigh scattering imaging of the particles provides indications on their size and their chemical composition.

Recently, 3-methyl -1,2,3-butanetricarboxylic acid (MBTCA) has been proposed as one relevant tracer compounds for biogenic SOA aging. Thus, in a second part, we will show that hygroscopic processes of MBTCA-containing particles, can be experimentally modeled in laboratory using levitation devices. In both cases, the connections between the microphysical state and chemical makeup of a particle with the transformation processes can be highlighted using these original experimental approaches.

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Aula de Conferencias del CEQUINOR
Boulevard 120, e/ 60 y 64, N° 1465