Photo-transformation of single $NaNO_3$ particle and influence on their hygroscopic properties

S. Seng[1], F. Guo[2], T. Ishikawa[2], S. Ishizaka[2], Y. Tobón[1] and S. Sobanska[1]

[1]Laboratoire de Spectrochimie Infrarouge et Raman, UMR CNRS 8516, Université de Lille, Sciences et Technologies, 59 655 Villeneuve d'Ascq Cedex, France
[2]Department of chemistry, Graduate School of Science, Hiroshima University, Higashi-Hiroshima, 739-8526, Japan

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Presenting author email: samantha.seng@ed.univ-lille1.fr

Marine aerosols represent more than half of global emission of particles into the troposphere (IPCC, 2014).

During their stay in the atmosphere, aerosols are subject to physicochemical transformations. These transformation processes have a direct impact on atmospheric chemistry and climate changes. One of the well-known atmospheric reactions is the sodium chloride conversion into sodium nitrate particles, when marine air masses are subjected to NO_x/NO_y gaseous species (Finlayson-Pitts 2003; Liu, 2007). Otherwise, aerosol particles are exposed to solar radiation. The photoconversion of nitrate ions into nitrite and peroxynitrite under solar radiation is well known in aqueous phase. Some similar process would be expected when aged sea salts containing nitrate particles are formed. While atmospheric photochemical processes in gas phase are well studied, only sparse works have been devoted to the photoreactivity of particles in the atmosphere.

In this presentation, we will show the studies carried out on sodium nitrate single particles when exposed to UV radiation and the influence of the photochemical products on their hygroscopic properties. We have used an acoustic levitation system coupled to micro-Raman spectrometry (See photo in Figure 1) to investigate the physical and chemical modifications of particles without the influence of a contacting surface.

Aqueous $NaNO_3$ droplets were irradiated for several minutes with UV-light (λ = 260 ± 6 nm) and nitrite and peroxynitrite ions were identify in the Raman spectrum for the fundamentals at 815, 1278 and 1330 cm^{-1} for aqueous NO_2^- ion (Belyi, 1995) and 980 cm^{-1} for $ONOO^-$ ion (Tsai *et al*) and as shown in Figure 1.

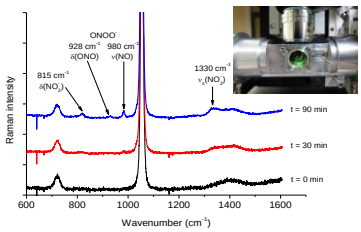

Figure 1. Raman spectra of a sodium nitrate particle at different irradiation time: t = 0, 30 and 90 min.

The rate formation of secondary products, i.e NO_2^- and $ONOO^-$, calculated for single particle agreed with those found previously.

By following the Raman spectrum and the size of the photodegraded particles as a function of the relative humidity, we demonstrated that the presence of irradiation products modifies the hygroscopic properties, especially for the deliquescence relative humidity (DRH) that was seen to decrease (Figure 2). In fact, we have evidenced both a MDRH (mutual deliquescence relative humidity) and a second DRH, as consequence of the final mixture in the drop, in agreement with the $NaNO_3/NaNO_2$ deliquescence diagram.

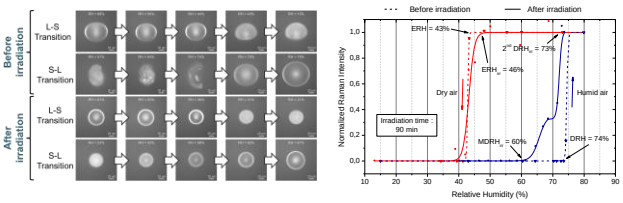

Figure 2. Relative humidity cycles of a levitated sodium nitrate particle before and after 90 min of irradiation according its Raman spectrum.

The phototransformation of single levitated particles, containing sodium nitrate, yield to the formation of NO_2^- and $ONOO^-$ ions which altered the hygroscopic properties of the nitrate containing particles. These results evidenced a subsequent implication for hygroscopicity properties of nitrate containing particles in the atmosphere which are in great abundance in polluted area.

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