Abilities of Raman spectroscopy to detect sulphates, nitrates and phosphates diluted in water

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The control of the quality of water is a growing need in our modern societies in order to insure the access of water in healthy conditions to an always rising number of people through the world. This leads to the obligation to detect all pollutants in flow water, rivers, basins, lakes… [1]. This challenge requires new and efficient techniques which are able to provide in situ and quick measurements.

Nitrates, sulphates, and phosphates have to be specially purchased since they are very water soluble and lead to negative incidence in the environment. They arise generally from pesticides used in agriculture [2,3].

Techniques generally used for pesticide detection are chromatographic methods like gas chromatography high performance liquid chromatography and mass spectrometry. They are relatively sensitive and reliable. However, they had limitations like complex procedure, time consuming sample treatments, and inability for on site detection. Here, we investigated the abilities of Raman probes to detect simultaneously the presence of several pollutants dissolved in water and to determine their concentration as well. Measurements have been done with a 532 nm exciting line using a spectrometer Kaiser RXN1. In Figure 1, one can see that an own signature can be detected by Raman probe for each kind of anion in different spectral ranges. As a consequence, the concentration of each salt in water can be deduced from an appropriate calibration.

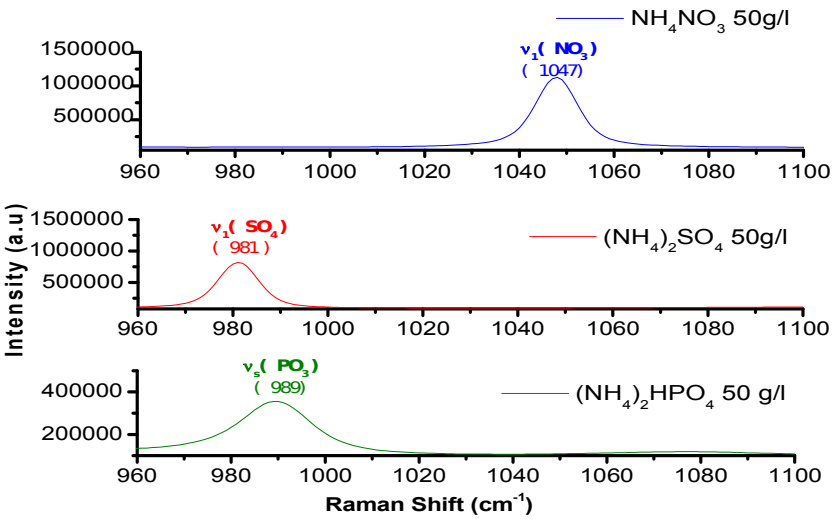

Figure 1. Specific Raman signatures of nitrate, sulphate and phosphate anions

The calibration of the Raman probe was achieved by recording the integrated scattered intensity of specific vibrational line of each pollutant as a function of the concentration varying between 0.5 and 5 g/l and prepared by titration. Linear laws were obtained as shown in Figure 2.

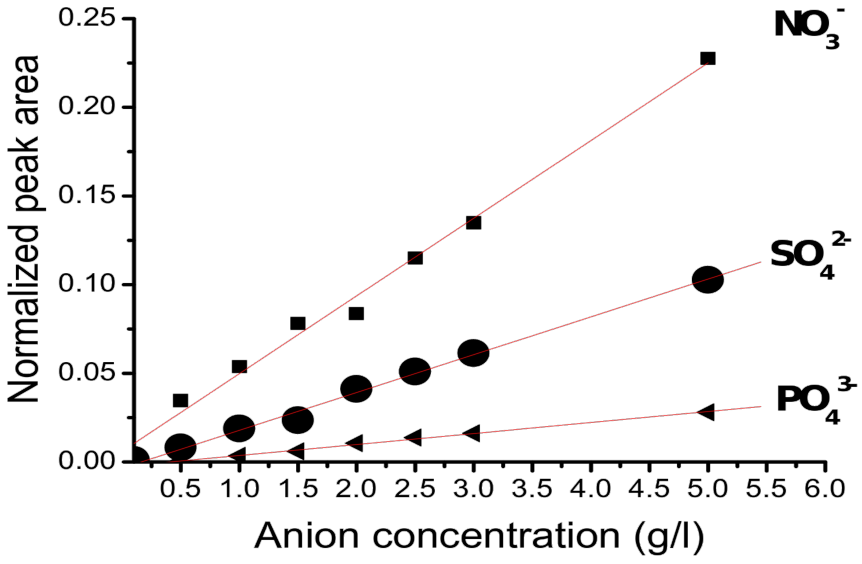

Figure2. Nitrate, sulphate and phosphate content dependence of integrated Raman intensity.

To get accurate results and gain in time and resolution, we then choose the suitable parameters. So we investigate, under laboratory conditions, the experimental conditions for a better detection and identification of pollutants. Here we report on the optimization of measurement conditions by successively studying the effect of the optical probe on the Raman spectra, the wave length, the laser beam intensity and the recorded time on the signal-to noise ratio.

References

[1] European Directive 98/83/CE.

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[3] N. Berenzen, R. Schulz, M. Liess, "Effects of chronic ammonium and nitrite contamination on the macro invertebrate community in running water microcosm", Water Research, vol. 35, no.14, pp. 3478-3482, 2001.