Raman Spectroscopic Analysis in Acoustically Levitated Drops

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Acoustic levitation has been shown to be a useful technique for contact-less handling of small solid and liquid samples in a gaseous environment with sample sizes typically of diameter 0.2−2 mm. Because of the lack of containment acoustic levitation inhibits wall effects and offers a contact-less handling medium for micro-sized samples. The combination of Raman spectroscopy with acoustic levitation, Raman Acoustic Levitation Spectroscopy (RALS), first coupled to Raman spectroscopy by Biswas[1], enables a time-resolved, contact-less monitoring of in-situ chemical reactions and physical and biological processes in a single drop suspended in a gaseous environment.

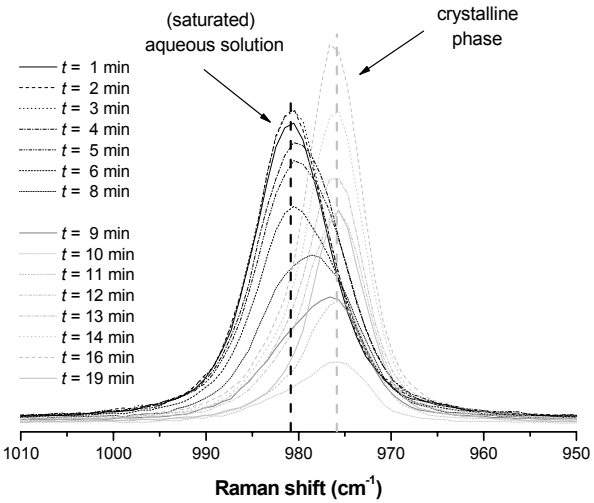

Figure 1: Raman spectra of evaporation and crystallization of a saturated aqueous solution of an acoustically levitated drop of $(NH_4)_2SO_4$ in ambient air at T = 20 °C and RH = 39 % (sampling every 30 s)

The main focus of this work has been to probe the utilization of RALS in quantitative analytical chemistry. The apparatus consists of an acoustic levitation device (Dantec/Invent) mounted on an x,y,z translation stage and coupled to a Renishaw micro Raman spectrometer. After carrying out some systematic tests to probe the sensitivity of the technique to drop size, shape and position, RALS has been successfully applied in monitoring sample dilution and pre-concentration, evaporation, crystallization, and an acid-base reaction. The spectra obtained through an experiment monitoring the crystallization of ammonium sulphate is shown in figure 1.

We have also applied the RALS technique to the field of biospectroscopy, recently in monitoring the malarial pigment, hemozoin in live malarial infected levitated red blood cells[2]. Live red blood cells, 5μL, in phosphate buffered saline were levitated in the acoustic levitator and the heme dynamics monitored through the exchange of oxygen. Raman spectra of levitated malarial infected red blood cells showed the distinct signature of the malarial pigment hemozoin.

[1] A. Biswas: *Thermal processing of o-terphenyl: A Raman study*. Appl. Spectrosc. 47 (1993) 458.
[2] L. Puskar, R. Tuckermann, T. Frosch, J. Popp, V Ly, D. McNaughton and B.R. Wood: *Raman acoustic levitation spectroscopy of red blood cells and Plasmodium falciparum trophozoites.* Lab on a Chip 7 (2007) 1125–1131.