OC-22: Luminescence of Lanthanides Triggered by Cavitation

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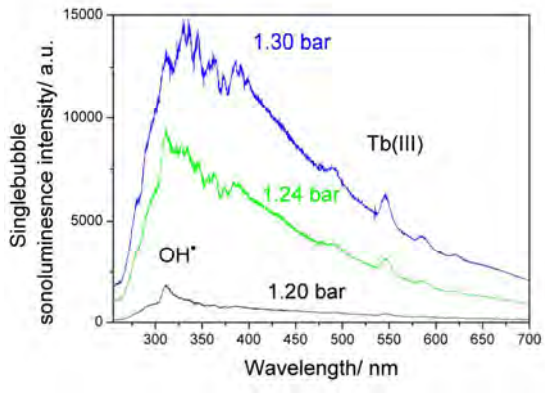
Spectroscopic analysis of singlebubble and multi-bubble sonoluminescence spectra is an important tool to study the activation of spectroscopic probes in solution, as for instance the excitation of alkali metal atoms in their chloride solutions. Their excitation is attributed to collisions with hot particles generated by the intense bubble collapse [1].

Another important kind of spectroscopic probes are trivalent lanthanides ions. Their luminescence is known to be excited by two possible pathways, first by photonabsorption and second by collisional excitation [2].

How will these ions behave when a broad band source such as sonoluminescence is used as a source of excitation? In this work we show, that the luminescence of some of the following ions, Tb(III), Ce(III), Eu(III) and Gd(III), can be obtained by a bubble cloud and a single cavitation bubble in water, as was shown by Sharipov *et al.* [3, 4]. However, the studies [3, 4] were performed only at 20 kHz and with a set-up of low resolution. The advantaged of this work is a set-up of high resolution, which allows the quantification of the sonoluminescence yield, the application of low and high ultrasonic frequencies (203 and 607 kHz), and a comparison of the multi-bubble spectra with those generated by a single cavitation bubble.

Quantification of the luminescence yields indicate that the source of Ce(III) emission is the simple process of sonophotoluminescence, in both types of sonoluminescence. In the case of Tb(III) the yields are higher indicating a different way of excitation, namely by collisions. For instance, the spectra of a terbiumchloride solution obtained from a single luminescent cavitation bubble at different acoustic pressures are shown. In addition to these two ways of excitation quenching of Gd(III) was observed, in both singlebubble and multi-bubble sonoluminescence. Thus, the proper experimental conditions had to be found to observe the luminescence of Gd(III) by means of complexation. Eu(III) shows an exceptional behaviour, because its luminescence is strongly dependent on the ultrasonic frequency and the acoustic power density.



Spectra from a 0.1 M $TbCl_3$ solution, containing 70 mbar of argon, at different acoustic powers.

References

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