OC-44: Sonoluminescence of Tb(III) at the Extended Solid-Liquid Interface

Matthieu Virot*, Rachel Pflieger, Johann Ravaux, Sergey I. Nikitenko

Institut de Chimie Séparative de Marcoule (ICSM), UMR 5257 CEA/CNRS/UM2/ENCSM, ICSM Site de Marcoule, BP 17171, 30207 Bagnols-sur-Cèze, France.
E-mail : matthieu.virot@cea.fr

The propagation of ultrasound in a liquid media may lead to acoustic cavitation, which is the nucleation, growth, and rapid collapse of vapor-filled micro bubbles. The collapse of these bubbles is known to generate extreme conditions in the medium ("hot spots"), going with high temperatures and pressures, shock waves, chemical reactions, and possibly the emission of light, known as sonoluminescence. Recent investigations considered the sonoluminescence as a source of excitation for photoactive species contained in the sonicated media. For instance, Ashokkumar and Grieser (1998) studied the 515 kHz excitation of pyranine in aqueous solution; and showed that the observed emission spectra were resulting from sonoluminescence excitation and not from chemical reactions that could occur in the sonicated media. This phenomenon, referred to as "sonophotoluminescence", was further observed during the sonication of fluorescent species in various aqueous and organic solutions. Later, these investigations led to the 20 kHz sonication of lanthanide salts in aqueous solutions (Sharipov et al. 2003, Sharipov et al. 2006). The Ln(III) excitation was suggested to occur *via* two mechanisms: (i) sonophotoluminescence, and (ii) collisional excitation of Ln(III) species at the bubble-solution interface with "hot" particles (radicals, excited molecules, etc.).

More recently, studies showed that the light emitted during the sonication of organic and inorganic slurries in appropriate solvent was resulting from mechanoluminescence (emission of light resulting from the mechanical action on a solid) rather than "true" sonoluminescence (Eddingsaas et al. 2006). In view of the above, the excitation of luminescent species with ultrasound, or sonoluminescence appears to be a quite new topic, scarcely reported in the literature. Most of the studies concentrated on homogeneous systems, and investigations dealing with heterogeneous media are even scarcer. To our knowledge, sonoluminescence phenomenon has never been studied at the vicinity of an extended solid-liquid interface. In the present work, we investigated the 20 kHz excitation of Tb(III) contained in a lanthanide phosphate pellet: $(Ce_{0.9},Tb_{0.1})PO_4$. Experiments were performed at 20 kHz in cooled aqueous solution sparged with argon, in a home-made reactor designed for the present purpose. Spectroscopic investigations revealed the possible observation of Tb(III) *f-f* $^5D_4$-$^7F_5$ emission (Figure 1). The emission origin was evidenced to result from a solid state excitation with the light emitted from the acoustically-generated cloud of cavitation bubbles, i.e. sonophotoluminescence.

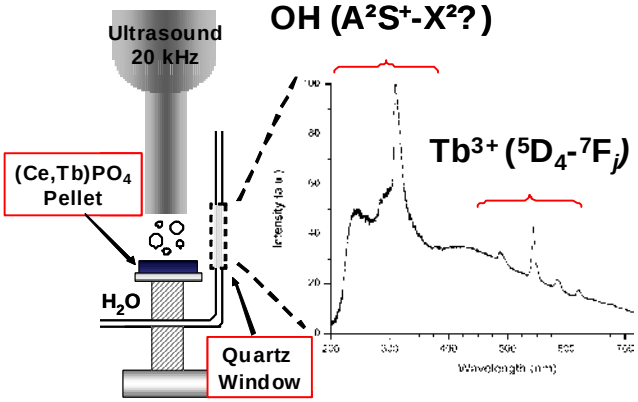

Figure 1: SL spectra observed during the sonication of $(Ce_{0,9}Tb_{0,1})PO_4$ pellet

References

Ashokkumar M. and Grieser F., 1998, Chem. Commun. 5, 561.
Eddingsaas N. C. and Suslick K. S., 2006, Nature 444, 163.
Sharipov G. L., Gaĭnetdinov R. Kh. and Abdrakhmanov A. M., 2003, Russ. Chem. Bull. 52, 1969.
Sharipov G. L., Gaĭnetdinov R. Kh. and Abdrakhmanov A. M., 2006, JETP LETTERS 83, 493.

Lviv Polytechnic National University Institutional Repository http://ena.lp.edu.ua