Plasma generation in NaCl and KBr solutions

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Plasma discharges, produced by applying high voltage in liquid, are widely applicable in a number of novel technologies [1–3]. They are widely used in nanoparticle fabrication [4, 5], in water purification [6–8], and in several biomedical applications [9]. The complex physics of the electric discharge phenomena in liquids is not fully understood. It is well accepted, however that, with low voltages and higher conductivity solutions, the plasma discharge in solution is highly influenced by the formation of a bubble or gas film around the electrode tip where the discharge occurs [10]. Recent work in our group has investigated the formation of this vapour layer around the electrode prior to plasma formation [11].

In this presentation, plasma discharges created by applying HV DC pulses in potassium bromide and sodium chloride solutions will be described. The plasmas were formed between two tungsten electrodes in a pin-to-pin configuration and with the electrodes immersed in the liquid. An Oscilloscope was used to record the voltage applied across the electrode, the current through the solution and the photomultiplier tube (PMT) signal, which measures light emission. A nanosecond gated intensified charge coupled device (ICCD) camera was used to record shadowgraphs with backlighting to observe the formation of the vapour layer. The ICCD camera was used without backlighting to observe plasma emission. Optical emission spectroscopy was used to observe emission spectra from the plasma.

The results indicate that initially there was formation of a gas bubble due to ohmic heating between the two electrodes followed by electrical breakdown across the gap. Time-independent broadband optical spectra of both solutions were measured. Emission lines of hydrogen (486.13nm, 656.28nm) and oxygen (777nm) appeared with both solutions. No evidence was found for emission from chlorine or bromine atoms. The difference between KBr and NaCl solution spectrum is the appearance of potassium emission at 767nm instead of the appearance of sodium (589.5 nm) emission. The broadening of Hα is observed as a Lorentzian profile, therefore it can used for estimation of the number of electron density using the value of full width half-Maximum. This study provides a promising approach for the investigation of plasma under KBr and NaCl solutions.

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