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SPECTROSCOPIC STUDY OF HYDROGEN ROTATIONAL, VIBRATIONAL AND TRANSLATIONAL TEMPERATURES IN A HOLLOW CATHODE GLOW DISCHARGE

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Abstract. Hydrogen hollow cathode glow discharges (HCGD) have been extensively used for study of fundamental discharge processes as well as for wide variety of applications. For instance, recently, this type of discharge was utilized for producing hydrogen by reforming natural gas (da Silva et al. 2006).

The translational or gas kinetic temperature in gas discharges is a parameter of utmost importance in the field of plasma chemistry while vibrationally excited neutral hydrogen molecules play significant role in the chemistry of weakly ionized hydrogen plasmas. This is why the modeling of cold, reactive hydrogen plasma includes rotational and vibrational energy of the hydrogen molecule. This is the reason why we study HC discharge parameters like rotational, translational and vibrational temperature.

Several diagnostic techniques are developed to determine gas kinetic temperature T_g like coherent anti-stokes Raman scattering (CARS), laser-induced fluorescence (LIF) and optical emission spectroscopy (OES). Here we selected OES. This diagnostic technique provides information about atom, molecule and ion density in excited and ground state, as well as rotational, vibrational, and gas temperature including the excitation temperature of certain group of excited levels. The technique is applied for measurements of the rotational T_{rot}, vibrational T_{vib} and determines translational temperatures in a hollow cathode glow discharge in hydrogen. The rotational temperature of excited electron energy levels is determined from the Boltzmann plot of intensities of rotational moleculelar hydrogen lines belonging to Fulcher-α diagonal bands. Following procedure described elsewhere (Astashkevich et al. 2006) the temperature of ground state rovibronic levels is evaluated. The constrains of rotational temperature are discussed in detail. The vibrational temperature is also determined, but from the relative intensities of the H_2 Fulcher-α diagonal bands. The dependence of these temperatures and their radial distribution within HC upon HC wall temperature was determined and discussed (Majstorović et al. 2007).

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