Balmer Alpha Line Shape of Hydrogen Isotopes for Monitoring Discharge – Metal Surface Interaction

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Abstract. We present results of a discharge – cathode wall interaction study based on comparison of the H_α and D_α Balmer line profiles. Both lines are emitted simultaneously from a low pressure DC hollow cathode (HC) glow discharge (GD). The HC was made of stainless steel (SS) or titanium (Ti).

The Balmer line shape in a low pressure discharge determine several broadening mechanisms, which will be discussed in some details at the Conference. From the point of view of discharge – cathode wall interaction the most important is, so called, excessive Doppler broadening (EDB). The present explanation of this phenomena is based on a *sheath collision model* (SCM). This model, among other processes, takes into account the influence of gas composition and cathode material to the Balmer line shape. During the process of the interaction of energetic atoms and molecular ions with discharge cathode the H or D atoms are implanted. The amount of implanted atoms and their implantation depth depends upon ion mass and energy, target material and target temperature. All these effects may be correlated with reflection coefficients that determine the number and energy of reflected fast H or D atoms relevant for excitation of the EDB component of the Balmer alpha line.

The experimental Balmer alpha line profile in this study represents a convolution of three Gaussian profiles resulting from different excitation processes. In $Ar/D_2/H_2$ gas mixture, the energies of excited atoms, H^* and D^*, are in the range from 33 eV (H_α) to 47 eV (D_α), but with large contribution of the broadest Gaussian, induced by EDB, to the Balmer alpha profile. The energy derived from the medium – width Gaussian is 1eV (H_α) and 2 eV (D_α). The width of narrowest Gaussian only slightly exceeds the instrumental broadening and it is always below 0.5 eV.

The possibility of distinguishing quantitatively the contribution of various processes to the line profile offers new approach for diagnostics of both, gas discharge and discharge – metal wall interaction. The details of the latter application will be discussed in more details at the Conference.