In-situ determination of surface characteristics by optical emission spectroscopy

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The optical properties of surfaces which are in contact with a plasma play an important role in plasma-solid interaction in laboratory and fusion plasmas. So, for instance, the wall reflectance impacts the signal from the continuum radiation in fusion plasma; the specular reflectance of mirrors defines the operation limit of spectroscopic diagnostics and the surface roughness affects the sputtering yield and the distribution function of reflected and sputtered atoms. One should admit, however, that the number of passive *in situ* diagnostics that are able to quantify even some of the optical characteristics of the surfaces and their temporal evolution in the plasma is extremely limited if available at all. Such analysis necessarily included until now external light sources such as lasers.

In this work, a novel approach to obtain the optical properties of the materials in the low-temperature (electron temperature below 5 eV) and low-density (neutral gas pressure below 0.1 Pa) laboratory plasmas is presented. It emerged as a result of the Doppler Effect observed for reflected atoms at the surface of interest and strong atom-atom cross-sections between argon or krypton and hydrogen. The strong emission is observed by applying to the surface a negative potential of about -100…-200 V. The so-called DSRM (**D**oppler-**S**hifted **R**eflectance **M**easurements) diagnostic provides *in situ* the reflectance of metallic surfaces, the degree of linear polarization and the temporal evolution of the reflectance. The information is read out from the line shape of hydrogen lines only. *In situ* measurements in the PSI-2 linear device provide a very good agreement of reflectance between measurement and known values for numerous materials (Al, Ag, C, Cr, Fe, Mo, Rh, Pd, Sn, W) [1]. For the first time, we demonstrated − in the absence of an external *ad hoc* light source − the recovery of the optical properties of mirrors by plasma cleaning (W impurity on an Ag substrate). Finally, the impact of the Drude theory in metals on the line shape of Balmer lines is clearly detected for Al surfaces.

References

[1] Dickheuer et al, Rev. Sci. Instrum. **89** 063112 (2018); Patent DE102016002270B3 (2017)