# Light reflection in the line shape of sputtered atoms in the linear plasma device PSI-2

Stephan Ertmer[1], Oleksandr Marchuk[1], Sven Dickheuer[1], Arkadi Kreter[1], and Sebastijan Brezinsek[1]

[1] *Forschungszentrum Jülich GmbH - Institut für Energie- und Klimaforschung - Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Germany*

The plasma facing components (PFCs) of future fusion devices will be subject to high heat and particle loads resulting in severe erosion. Plasma spectroscopy is a powerful means to monitor the gross erosion e.g using S/XB-values [1], the number of ionization events per photon. For this the absolute intensities of the line radiation emitted by the sputtered particles are required. To measure the absolute intensities in a fusion device usually the spectrometer line of sight is directed nearly perpendicular to the PFC surface. It has been shown in [2] that for carbon (C) surfaces the light emitted by the sputtered particles is reflected at the target surface and has to be taken into account for the measurements. We show experimentally, that this effect is also seen, and even increased compared to C, for high-Z metallic surfaces.

The experiments have been performed in the linear plasma device PSI-2 [3]. Devices like PSI-2 are useful means to test PFCs in stable plasma conditions. Temperature, density and ion species can be controlled and varied. The plasma ions are accelerated due to a bias voltage onto the target leading to material erosion. Aluminum, molybdenum and tungsten targets have been exposed to an argon plasma with an electron temperature of 3 eV and an electron density of approximately $3.5 \cdot 10^{12}\,\mathrm{cm}^{-3}$, which leads to an ionization length of about 10 cm. The mono-energetic impact energy of the incoming ions was in the order of 100 eV. We adjusted one of the lines of sight of a high resolving spectrometer, with a dispersion of $\mathrm{d}\lambda = 0.0063\,\text{Å}$, perpendicular and another one parallel to the target surface. The sputtered particles get excited in the plasma and emit light in every direction. Due to the Doppler effect the detected wavelength $\lambda_\mathrm{D}$ of moving particles is shifted and given by:

$$\lambda_\mathrm{D} = \lambda_\mathrm{S}\sqrt{\frac{1-\frac{v}{c}}{1+\frac{v}{c}}}. \tag{1}$$

Where $\lambda_\mathrm{S}$ is the emitted wavelength, $v$ is the velocity of the particle and $c$ the speed of light. Light that is emitted in the direction of the spectrometer is blue-shifted and light that is emitted in the direction of the target is red-shifted. We show that for sputtered aluminum, molybdenum and tungsten particles the reflected portion can be inferred from the line shape of the detected signal and affects the measured absolute line intensity. Moreover, the degradation of the optical properties of a polished aluminum surface was detected in the line shape of the emission from sputtered particles. The Doppler effect in the line shape of different line of sights can be used to model the angular and energy distribution of the sputtered particles. Both effects have already been shown for fast reflected hydrogen atoms [4]. Other broadening effects like the Zeeman effect can be neglected because of a weak magnetic field in the order of 0.1 T. Conclusions from the experiments have to be considered for S/XB-values and codes used for modeling PFC erosion.

## References

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