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Monitoring Removal of W Layer from Ag Substrate Using Balmer-α Emission of Backscattered Hydrogen Atoms in Low Density Gas Discharge

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The Doppler-Shifted Reflectance Measurements diagnostic is applied for in-situ measurements of a total spectral reflectance of the sample during the transition phase induced by physical sputtering of a layer of tungsten (W) from a silver (Ag) substrate. The sputtering of a 4 μm layer of W is monitored at the Balmer-α line $\lambda_0 = 656$ nm with a temporal resolution of 60 s corresponding to a thickness of $\approx \lambda_0/100$ in the absence of other light sources. The sample was exposed to a mixed argon (Ar) and hydrogen (H) gas discharge in the linear plasma device PSI-2, where the Ar^+ ions, accelerated by the applied negative potential of -180 V, were intrinsically used for sputtering of the deposited film. The sputtered W or Ag were also monitored by optical emission spectroscopy. It is shown that in low density gas discharges the Doppler-Shifted Reflectance Measurements diagnostic is, in providing the value of reflectance, extremely sensitive to the transition phase between W and Ag — as compared to resorting to the W–I and Ag–I emission lines intensities. It could thus be directly applied to cleaning plasma discharges with the presence of Ar and H or deuterium (D) ions.

topics: Balmer lines, sputtering, emission spectroscopy, thin films, line shape

This article was originally published in October 2020 with the incorrect version of Fig. 4. The three time stamps of the recorded spectra have unfortunately been shown incorrectly in the legend. The correct time stamps are the same as those given in Fig. 6 of the same paper, where the emission spectra of sputtered W–I and Ag–I lines during sputtering of 4 μm W deposited on an Ag substrate have been shown. The transition between W and Ag ends at 820 min and not at 700 min of plasma exposure. This mistake does not have any influence on the results and conclusion of the original paper.

The correct version of Fig. 4 is given as Fig. 1 on the following page. The authors apologize for this error.

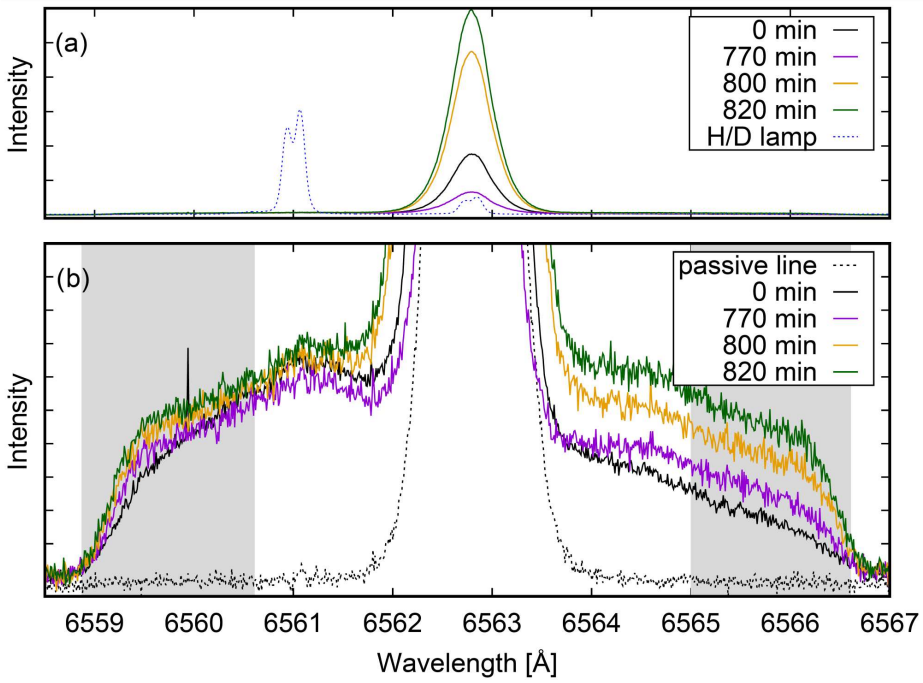

Fig. 1. Emission spectra of the Balmer-α line induced by backscattered fast atoms in the Ar–H discharge during the transition between the W layer and Ag substrate at different time stamps. The spectra of the Balmer-α line, including the spectrum from the calibration lamp containing H_2 and D_2 gases, are shown in (a). The details of the emission induced by backscattered atoms at different times are exemplified in (b). The Balmer-α line observed without a sample is shown using the black dashed line. The grey zones show the intervals where no overlap between blue- and red-shifted signal occurs. Both spectral regions are used to obtain the value of total reflectance.