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Ion-induced plasmon excitation on clean and oxidized silver surfaces

Yu. A. Bandurin, A.I. Dashchenko, I.E. Mitropolsky and S.S. Pop
Uzhgorod State University, 294000 Uzhgorod, Ukraine

Photon emission during bombardment of silver surfaces by ions and electrons was investigated. In particular the influence of adsorbed and implanted oxygen atoms upon the shape of the observed continuum radiation was studied. It was found that the maximum of continuum radiation near the wavelength 330 nm is correlated with the presence of oxygen on the silver surface.

1. Introduction

The bombardment of silver surfaces by different gas ions is accompanied by photon emission over a wide spectral range. The spectrum arising from ion-photon emission consists of continuum radiation (CR), together with spectral lines emitted by excited sputtered and scattered particles [1]. These spectral lines are emitted by particles escaping from the surface, however the observed CR comes from the surface of the target and is not directly connected with the ejection of sputtered or scattered particles (i.e. clusters) [2]. The maximum of the CR lies in the ultraviolet region of the spectrum, near the wavelength of radiative relaxation of silver surface plasmons. Comparison of the CR observed during bombardment of silver by inert gas ions [1] with that observed during electron bombardment [3] shows that many parameters of CR (i.e. the shape, wavelength position of the maximum, the dependence of radiation intensities on the observed angle θ of radiation, the linear polarization of radiation) are similar [2].

The position of the CR maximum on the wavelength scale was found to be at $\lambda = 360$ nm during bombardment of silver by He^+, Ne^+ and Ar^+ ions [1]. In the further experiments [2,4] we observed the CR to have two maxima, one at $\lambda_1 = 330$ nm and the other at $\lambda_2 = 360$ nm when silver was bombarded by H^+, H_2^+ and H_3^+ ions. The relative intensity of these two maxima strongly depends on the observation angle θ and on other experimental conditions. Indeed we noticed [2] that the appearence of the short wavelength CR maximum could be correlated with the presence of oxygen atoms on the surface of silver. In this paper we present the results of some new experiments which directly show the influence of adsorbed or implanted oxygen atoms on continuum radiation arising from silver surfaces during ion and electron bombardment.

2. Experiment

The experimental configurations and equipment are described in detail in ref. [2]. In this paper we compare the photon emissions from silver targets bombarded with different ion species O_2^+, K^+, H^+, H_2^+, H_3^+, He^+, Ne^+ and Ar^+. In addition an electron gun was put into the vacuum chamber and utilized. The energy E_0 of incident ions varied from 6 to 21 keV and the energy of bombarding electrons was fixed at $E_0 = 570$ eV. The angle between the direction of electron bombardment and the plane formed by the direction of ion bombardment, collection of radiation and the normal to the target surface, was 11°. The CR spectra of electron-induced photon emission was measured both before ion bombardment and after. Also we studied the shapes of spectral lines emitted by excited scattered hydrogen atoms. In such experiments the width of monochromator slits 0.01 mm fixed the spectral resolution at 0.02 nm.

3. Results and discussions

The main difference observed in the spectra of ion-induced photon emission of the silver surface was in the shape of the continuum radiation which appeared during bombardment by different ions. For example, fig. 1 compares the shapes of the CR measured in the $He^+ \rightarrow Ag$ (curve 1) and in the $H_3^+ \rightarrow Ag$ (curve 2) interactions. It is seen that there is only one CR maximum in the case of He^+ ion bombardment located near $\lambda = 360$ nm. Whereas, when H_3^+ ions were used, we observed two maxima in the CR spectrum. The position of these two maxima slightly changed with the wavelength scale when the observation angle θ varied. In the angle interval $45° \leq \theta \leq 80°$ the positions of both maxima varied from 330 to 340

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