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RELAXATION OF PLASMON EXCITATIONS IN CONSTRUCTION MATERIALS OF THERMONUCLEAR FACILITIES *)

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During the interaction of plasma with the materials of the in-chamber surfaces of thermonuclear facilities, approximately 50% of the inelastic energy losses of charged plasma particles transitions into the excitation of plasma or Langmuir waves. A critical analysis of experimental data on electron emission observed during electron and ion bombardment of solids is provided. Analysis of X-ray photoelectron spectroscopy spectra and characteristic energy loss spectroscopy is performed to determine the lifetime of plasmon excitations. Experiments on the observation of photon emission with energy equal to plasmon energy are presented.

The electron-ion plasma of a solid interacting with an electron flow, whose energy significantly exceeds the Fermi energy, is considered based on quantum electrodynamics. It is shown that the quantum description of plasmons leads to the concept of electromagnetic vacuum of longitudinal Langmuir waves. The interaction of plasmons with the plasmon vacuum leads to the relaxation of plasma excitations and the birth of longitudinal photons. The presented mechanism of plasmon relaxation explains a number of phenomena previously considered anomalous, namely, the polarization of electron-photon emission observed at plasmon frequencies, and features in the spectra of secondary electron emission at plasmon energies observed during electron and ion bombardment. A comparison of electron-photon emission spectra with differential cross-sections of inelastic energy losses of fast electrons for plasmon excitation is presented (Fig. 1).

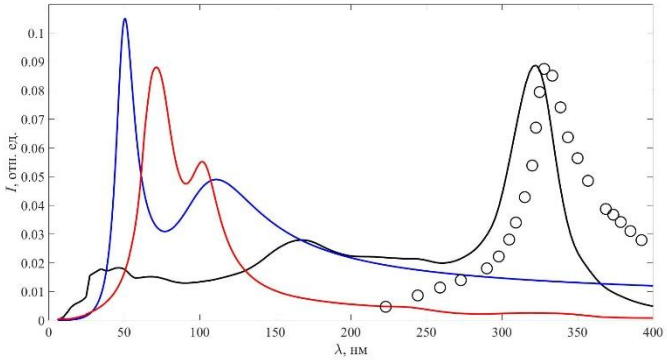

Fig. 1. Lines - differential cross-sections of inelastic electron energy losses for plasmon excitation in W (blue), Si (red), and Ag (black) [1]. Circles - optical spectra of electron-photon emission in Ag [2,3]. Data are presented for energy of 1 keV

Energy spectra of secondary electron emission are presented, showing pronounced maxima at plasmon energies. This phenomenon should be considered as a photoelectric effect on longitudinal photons resulting from the relaxation of plasmon excitations. A similar effect was observed during the bombardment of Al and Mg with He, Ne, and Ar ions [4].

References

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