Modeling of Guiding of 10 keV Electron Beam by Planar Dielectric Surface

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***Abstract*—Study of 10 keV electron beam reflection from a single planar dielectric surface was made. Guiding effect for some part of the beam was observed within grazing angles of incidence. Ionization, electron emission and drain of the surface charge were considered in the computer model to explain the results.**

The interaction of electrons with dielectric surfaces has been discussed by many scientific groups in the past few decades [1-7]. Some works on the interaction of electrons with matter were focused at study of opportunity to guide electrons by dielectric channels of different geometries. Experimental data indicate the possibility of forming beams by means of macrochannels, but still there is no macroscopic model to explain the effects arising from the interaction of the electron beam with the surface at grazing incidence. Experiments on the interaction of the grazing electron beams with flat dielectric surfaces revealed a number of features [8]. The results of further experiments allow to make some assumptions about the character of occurring processes and to build a model that takes into account such factors as ionization, electron emission and drain of the surface charge.

Study of electron beam reflection from a single planar dielectric surface was made. A planar samples were irradiate at grazing incidence with an incident 2 mm diameter beam of 10 keV: current density 0.1 A/m^2, initial divergence <0.5deg., the monochromaticity of the beam is better than 0.1%. The experiments with Plexiglass, Al_2O_3 and silicate glass plates show different dynamics of the beam forming in depends of different length, thickness and material.

Surface charge distribution generated by grazing electron beam, defines the possibility to guide the beam, and also affects the shape of the beam cross section. For the description of the electron-surface interaction we propose classical model of the particle collisions with insulating surface taking into account secondary electron (SE) emission. When the electrons hit the surface they create self-organized charge system on that surface and the charge of every hit area depends on the collision angleθ. The expected dependence of SE yield was taken as it showed at formula (1). In order to make fast dynamic calculation we use "jet" model described in work [9].

$$\sigma(\theta) = -1 + \frac{G}{1+\exp(G\theta/\theta_c)}, \qquad (1)$$

here $\theta_c$and G are the parameters that can be found from the computing and the experiment. Some results of calculations and experimental data for Al_2O_3 plate of 0.2 mm thickness and 40 mm length are shown in figure 1.

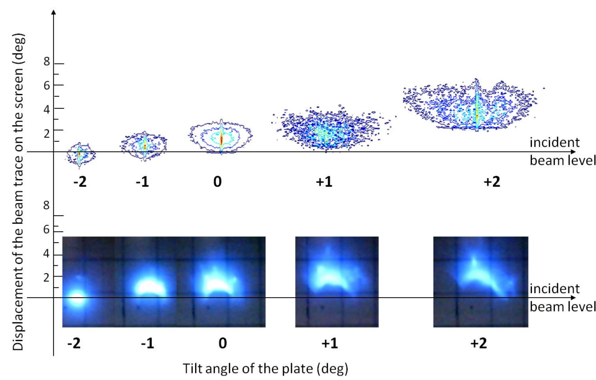

Figure 1. Simulation and experimental data of displacement of the trace of the beam in dependence of plate tilting (calculations with parameters G=10, θ_c =-5)

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