Simulation of fast electron transport in thin metal and fullerite films

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Electron beams are well known to generate swarms of the secondary, back-scattered and re-diffused electrons when collide with a target. Some details of this process were considered in this work for the cases of fullerite C_{60} films used in electron-beam lithography [1] and of micro-strip metal detectors [2]. In the first case, electron beam generates a swarm of secondary and re-diffused electrons losing their energy in numerous inelastic collisions some part of which leads to creation of polymeric bonds between fullerenes. To accelerate the polymerization process, one should find optimal characteristics of irradiating electron beam. In the second case, electron beam passes through thin metal film inducing emission of secondary electrons, therefore a positive charge emerges on the electrically isolated film. This charge and energy distribution of emitted electrons should be known to optimize parameters of extracting electric field.

The model of electron-atom interaction for primary electrons in the keV energy range and for secondary electrons in the eV energy range, early developed in [3], was applied to description of the above processes. Elastic electron collisions as well as electron-phonon interaction were described by using optical potential. Ionization of deep atomic levels was considered by use of the Kim-Rudd model. Ionization of the valence and conduction bands and plasmons generation were described by the Penn model and experimental data. The Monte-Carlo programme package has been created and all collisions and trajectories of the primary and secondary electrons were calculated till the moment when their energies become below the work function.

The conducted simulation has shown that the average kinetic energy of the ejected electrons is larger when they start from deeper atomic levels, which results in additional electron emission from target. As a result, many of generated and re-diffused electrons are stopped changing the energy of the most energetic electrons of the electron cloud and decreasing their energy down to the value just above the work function. In addition, some weak nonmonotonicity of the total number of fast electrons moving inside of the target is observed when the primary electron beam energy is sufficient for ionization of deep atomic levels.

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