3 - 13 Guiding of Electron Beams by Macro-insulating Units

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In our previous work[1], using a pair of grooved SiO_2 parallel plates, we had obtained stably guided electron beams without energy loss in the incident energy range of 800∼2 000 V. The very high-current (up to tens or hundreds of nA/mm^2) electron beams were adopted. A 128-strip electrode array with a 128-channel picoammeter system[2], combined with an electrostatic deflector were employed to monitor the transmitted electron beams.

To better understanding the guiding processes of electron beams passing through the insulting plates, several grooved parallel plates made by different insulating materials were adopted to study the dependence relative to the guiding beams on the conductivities of these materials. As shown in Fig. 1, the guiding behaviors among these different insulators are quite same. Moreover, we found that the gap between two symmetric plates might play significant role in electron guiding. Furthermore, a wide range of beam current (tens of pA/mm^2 to tens of nA/mm^2) were used to investigate the dependence of guiding effect of electron beams on beam fluxes. It is shown in Fig. 2, that the guiding behaviors with different beam fluxes keep same, and suggests that more research with much lower electron current should be expected.

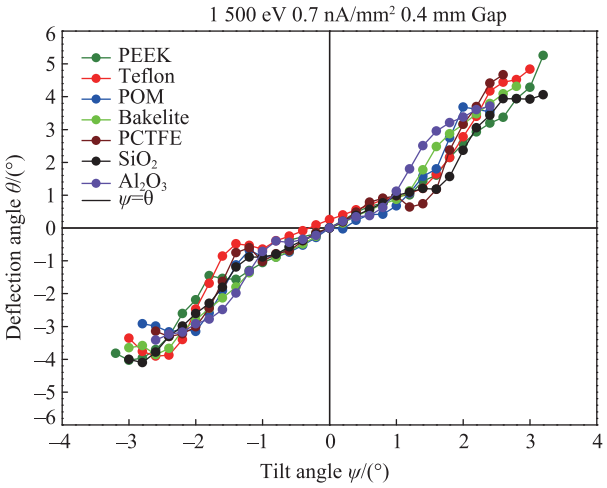

Fig. 1 (color online) Deflection angle as functions of the tilt angle for 1 500 eV, 0.7 nA/mm^2 electrons passing through different parallel plates with 0.4 mm gap.

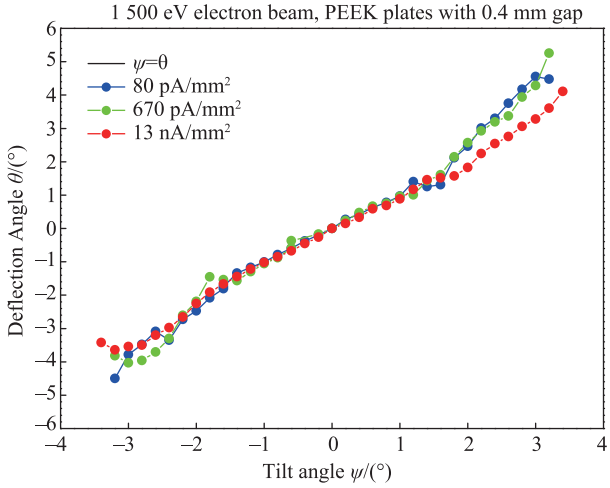

Fig. 2 (color online) Deflection angle as functions of the tilt angle for 1 500 eV electrons with different current, 80 pA/mm^2, 670 pA/mm^2, and 13 nA/mm^2, passing through parallel PEEK plates with 0.4 mm gap.

The present results suggest that the guiding effect of high-current electron beams by macro-insulating units may be due to the combined contributions of the individual atom scattering and the repulsive field on material surface.

References

[1] Y. Xue, D. Yu, J. Liu, et al., Appl. Phys. Lett., 107(2015)254102.

[2] D. Yu, J. Liu, Y. Xue, et al., Rev. Sci. Instrum., 86(2015)115102.