PROGRESS IN RESHAPING FIELD ELECTRON EMISSION THEORY FOR THE BENEFIT OF EXPERIMENTAL SCIENTISTS AND TECHNOLOGISTS

Richard G. Forbes
Advanced Technology Institute & Department of Electrical and Electronic Engineering,
University of Surrey, Guildford, Surrey GU2 7XH, UK
Permanent e-mail alias: r.forbes@trinity.cantab.net

ABSTRACT

This Presentation provides an overview of, and reports recent progress in, a long-term multi-stage project that aims to put field electron emission (FE) theory onto a better scientific basis. Part of this involves developing a slightly modified form of theory that involves parameters that are more useful for the interpretation of experimental data than are the parameters involved in the older "1950s style" FE theory that has been extensively used for modelling and simulation. This slightly modified theory is based on theoretical advances made in the last ten years or so (so-called "21st Century" FE theory). More detailed accounts of the overall project have been given elsewhere [1,2].

The first project stage involves various individual proposals that aim to improve data interpretation within the framework of the almost universally used (but often not physically realistic) *smooth planar metal emitter (SPME) theoretical methodology*. Amongst these are proposals that aim to: (1) remove known entrenched errors from the literature; or (2) update the various (now-obsolete) theoretical approximations often used in technological literature, or (3) improve the precision with which the parameter "formal emission area" can be extracted from experimental current-voltage data. Part of the aim is to bring all theoretical accounts in the literature that are based on SPME theoretical methodology up to a common modern starting point for further development. Individual proposals where useful recent progress has been made (e.g., [3]) will be reported.

For many real emitters SPME theoretical methodology is wildly unrealistic, particularly so for small-radius carbon nanotubes. It is long overdue that we seriously begin to develop proper current-voltage data-interpretation theory for so-called "point-form" emitters that have the shape of a pointed needle or a rounded post, or are otherwise "pointy". A brief account will be given of recent progress [2,4,5]. Expected future stages of the long-term project will be briefly outlined.

Aspects of this presentation will be supported by Posters.

References

[1] R.G. Forbes, 6th ITG International Vacuum Electronics Workshop, Bad Honnef, September 2018.
[2] R.G. Forbes, J.H.B. Deane, A.G. Kolosko, S.V. Fillipov, E.O. Popov 32nd International Vacuum Nanoelectronics Conf. & 12th International Vacuum Electron Sources Conf., Cincinnatti, July 2019. [Technical Digest, p. 23.] doi:10.13140/RG.2.2.32112.81927
[3] R.G. Forbes, J. Vac. Sci. Technol. B **37**, 051802 (2019); J. Appl. Phys. **126**, 210901 (2019); R. Soc. Open Sci. **6**, 190912 (2019); M.M. Allaham et al., J. Electr. Eng. Slovak **71**, 37 (2020).
[4] C.P. de Castro, et al., J. Chem. Inf. Model (published on line); doi:10.1021/acs.jcim.9b00896.
[5] R.G. Forbes, J.H.B. Deane, A.G. Kolosko, S.V. Fillipov, E.O. Popov, 32nd International Vacuum Nanoelectronics Conf. & 12th International Vacuum Electron Sources Conf., Cincinnatti, July 2019. [Technical Digest, p. 96.] doi:10.13140/RG.2.2.35337.19041