CRETE CENTER FOR QUANTUM COMPLEXITY AND NANOTECHNOLOGY

ΣΕΜΙΝΑΡΙΟ ΚΕΝΤΡΟΥ ΚΒΑΝΤΙΚΗΣ ΠΟΛΥΠΛΟΚΟΤΗΤΑΣ & ΝΑΝΟΤΕΧΝΟΛΟΓΙΑΣ/ CCQCN SEMINAR

Friday, 18 September 2015

11:00-12:00

3rd Floor Seminar Room

Theory of Near Field Emission Scanning Electron Microscopy

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Abstract

Near Field Emission Scanning Electron Microscopy (NFESEM) is a new form of electron microscopy, developed during the last 6 years. It is capable of acquiring Scanning Electron Microscopy (SEM) type images with almost equivalent resolution, without any use of focusing or collimation of the beam. The latter is very promising since the focusing system is a significant part of the cost of the SEM. It is achieved by placing the emitter in a small distance *d* (some nm) from the sample-anode and using very sharp tips for emitters.

The characteristics of the NFESEM raise questions about the characteristics of Field Emission (FE) which the existing FE theory fails to answer sufficiently. Thus it is required to theoretically analyze the physical properties of FE when *d* is some nm and the emitters are highly curved (radii of curvature R~1-20nm) as happens in the NFESEM configuration.

The standard Fowler-Nordheim (F-N) theory of FE is applicable only to quasi-planar emitters (R>>2nm). In this work, the F-N theory is generalized starting from general principles and using approximations of general validity. An F-N-type equation is derived for the description of FE from sharp emitters. Upon applying our equation to experimental data, one may deduce 1) the radius of curvature of the emitter and 2) standard FE parameters –e.g. enhancement factor- with much better accuracy than that by using the F-N equation. Experimental confirmation of the validity of our equation is given by the data of three different experimental groups. Furthermore, the standard 1-dimensional theory of FE fails to predict the unexpectedly good lateral resolution (LR) of the NFESEM. Hence, there is needed an advanced calculation of the distribution of the field emitted current and especially the beam width of the NFESEM, which mainly determines its LR. For the latter, ellipsoids are used to emulate the geometry of the tip and 3-dimensional Jeffreys-Wentzel-Krammers-Brillouin (JWKB) theory for the tunneling. The beam width (spot size) of the NFESEM is predicted as a function of its physical parameters. The results are in good agreement with experimental findings about the LR of the NFESEM.

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CAPACITIES