Theoretical Consideration of LEEM Schemes Using an Electrostatic Micro-Lens within a Scanning Probe Microscope Cantilever

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Instruments with combined scanning probe microscope (SPM) and scanning electron microscope (SEM) capabilities have been under development and commercially available for over 10 years now [1]. However, little attention has been given to the possibility of incorporating the final objective lens into the SPM cantilever. Electrostatic micro-lens systems are proposed and analysed in this work which can be readily incorporated into a SPM cantilever, as demonstrated through the prior micro-fabrication of key system components [2]. These schemes are likely to offer a working distance < 10 micron and offer advantages for low energy electron microscopy (LEEM), which can be performed alongside conventional SPM in the proposed schemes.

A typical modelled scheme is given in Figure 1(a). In this model, an incoming beam of nominal energy 500 eV and half angle 10 mrad is assumed. This can readily be brought to a focus 5 micron below the lower electrode, with a sample-side beam energy of 20 eV and a half angle at the sample of alpha = 50 mrad, while the dielectric layers are subjected to electric field strengths $< 5 \times 10^7$ V m^{-1}. Using a wave optical treatment, to combine the effects of diffraction, spherical aberration and chromatic aberration, a point spread function with a FWHM of 3.1 nm is determined, as in Figure 1(b). Thus, final system resolution comparable to current LEEMs appears realisable.

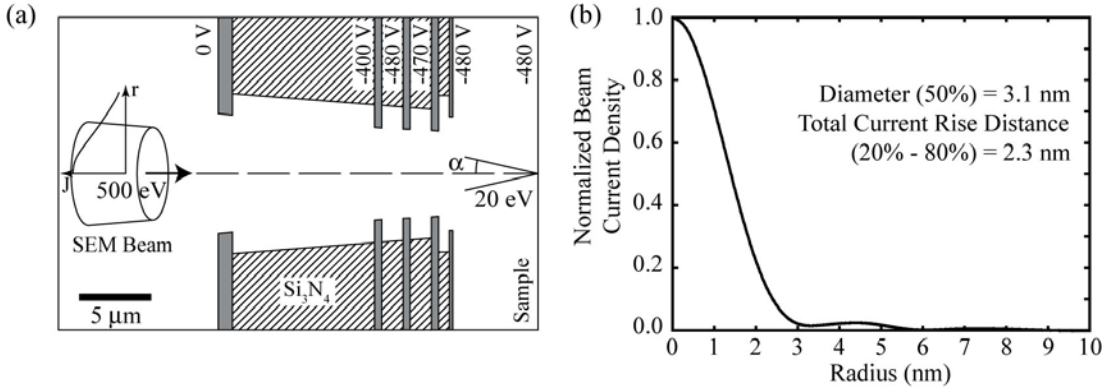

Figure 1 –Typical modelled arrangement for low-energy focused electron beam operation (a) and calculated polychromatic point spread function (b).

[1] U. Stahl, C. W. Yuan, A. L. de Lozanne, M. Tortonese, Appl. Phys. Lett. **65**, 2878 (1994).
[2] A. M. Blackburn, D. G. Hasko, D. A. Williams, Microelectron. Eng. **73-74**, 797 (2004).