Title

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Modeling the acceleration field and objective lens for an aberration corrected photoemission electron microscope

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The second generation photoemission electron microscope (PEEM2) at ALS has reached its design goal and a spatial resolution of 20 nm has been achieved [1]. The resolution of the PEEM2 microscope is mainly limited by the aberrations of the acceleration field, the objective lens, and the diffraction at the angle defining aperture and cannot be reduced by modifying the design. Aberrations must be corrected in order to remove their deleterious effects on the imaging properties of microscope for higher resolution. The most promising approach to an aberration corrected PEEM is the introduction of an electrostatic mirror into PEEM[2-4]. An electrostatic mirror can be used for the simultaneous correction of chromatic and spherical aberrations. The design goal of an aberration corrected PEEM (called PEEM3 in this paper) is to obtain the highest throughput, at a resolution commensurate with the resolution determined by electron scattering within a sample (typically 2nm).

An aberration free magnetic separator has being designed to direct the beam coming from the objective into the aberration correcting mirror, and then to redirected the beam back along the optical axis of the instrument. This separator has aberration of < 1nm for the full secondary electron emission energy profile over a 90^0 aperture for 20KV extraction field and an objective lens magnification of 20. In order to design the correcting mirror that ultimately sets the resolution, a full description of the aberrations of the extraction field and objective lens are required.

This paper describes the modeling of the optical properties of the acceleration field and objective lens. Theory to calculate the aberrations of the extraction field was derived , and extended to include relativistic effect. The analysis of microscope's electron optical performance and aberrations have been performed using an analytical model as well as a raytrace method. These two methods agree and using the flexibility of the computational approach allows us to rapidly optimize the design

References

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