Progress Towards A Monochromatic, Aberration-Corrected, Dual-Beam LEEM (MAD-LEEM)

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Monochromatic, aberration-corrected, dual-beam low energy electron microscopy ([1], MAD-LEEM) is a novel technique that is directed towards imaging nanostructures and surfaces with sub-nanometer resolution. It combines a monochromator, a mirror aberration corrector, an energy filter, and dual beam illumination in a single instrument (Fig. 1a). MAD-LEEM is designed for the purpose of imaging biological and insulating specimens, which are difficult to image with conventional LEEM, Low-Voltage SEM, and TEM instruments. The low impact energy of the electrons is critical for avoiding beam damage, and the dual beam approach mitigates charging. A potential application for MAD-LEEM is in DNA sequencing. The key advantages of the MAD-LEEM approach for this application are the low electron impact energies, the long read lengths, and the absence of heavy-atom DNA labeling. Experimental results from bulk specimens with immobilized single-base oligo-nucleotides demonstrate that base specific contrast is available with photo-emitted (Fig.1b), Auger, and reflected electrons. Simulations (Fig. 1c) predict that images will yield low sequencing error rates if the microscope resolution is improved to give blur values of 1 nm or less.

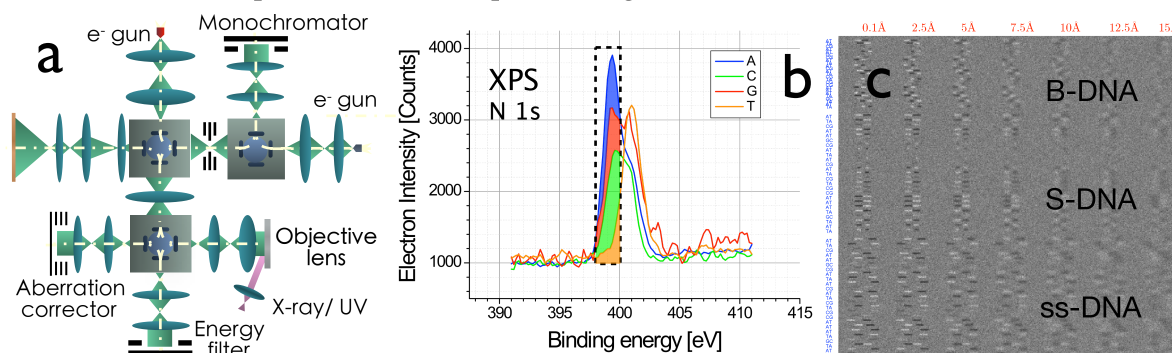

***Figure 1**: a - Schematic layout of a MAD-LEEM column; b - Nitrogen 1s XPS spectra for bulk single-stranded DNA homopolymeric 20mers; c - Simulated XPS-mode images of sequences with 25 random base pairs of B-DNA, S-DNA, and the ss-form of S-DNA.*

Acknowledgements

This project was supported by Grant # R43HG006303 from the NHGRI. H.H.J.P. and R. W.D. were supported in part by NIH grant HG000205. Portions of this work were performed at the National Center for Electron Microscopy, supported by the Office of Basic Energy Sciences, U.S. Dept. of Energy, Contract # DE-AC02-05CH11231. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NHGRI or the National Institutes of Health.

References

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