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A New SEM Column Combining Ultra-High Resolution and Flexible Scanning

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The critical parts of the scanning electron microscope optical system are the technology of the objective lens (that determines the resolving power) and the configuration of the deflecting elements used for scanning. However, requirements for high resolution, high beam deflection and analytical compatibility are usually in conflict with each other because of design limitations. A significant advance towards the optimal design was the introduction of Wide Field Optics™ technology incorporating two objective lenses located below and above the double-stage scanning deflectors. This configuration provides several display modes which delivers both high resolution imaging and a large field of view using optimization of the scanning pivot-point position and an advanced engine for correction of optical distortion. The technology further allows a mode with controlled depth of focus and a rocking beam mode with the pivot point on the sample [1]. Another technology uses ultra-high resolving power with immersion optics, but the resolution in magnetic-field-free mode is lower [2].

Here we present a new electron column that delivers ultra-high resolution in the field-free mode while preserving all aspects of the Wide Field Optics. Especially, an extra wide field of view is now possible (see Fig. 1). The column combines a high-potential tube with magnetic-electrostatic objective lens. The electrostatic part is located inside the magnetic polepieces with a negligible portion of both magnetic and electrostatic fields getting through to the sample. Thus the resolution at low beam energies is improved without restricting sample tilt which is especially critical for analytical applications or focused ion beam (FIB) milling. The column reaches resolutions of 1.7 nm at 1 kV in field-free mode and 1 nm at 15 kV. The probe current is up to 400 nA.

A new detection system inside the SEM column was developed for advanced control of image contrast and low-kV operation. The in-column detectors allow the filtering of secondary electrons, energy filtering of back-scattered electrons and angular BSE selection.

Versatility of the SEM column was the key for the design. As a result, a unique combination of field-free resolution, wide-angle rocking beam and wide field of view for live sample navigation has been achieved in the category of UHR SEM and FIB-SEM.

References:

[1] Wide field optics description at www.tescan.com
[2] J Jiruse, M Havelka and J Polster, Microsc. Microanal. **22** (Suppl **3**), 2016, p. 578-579

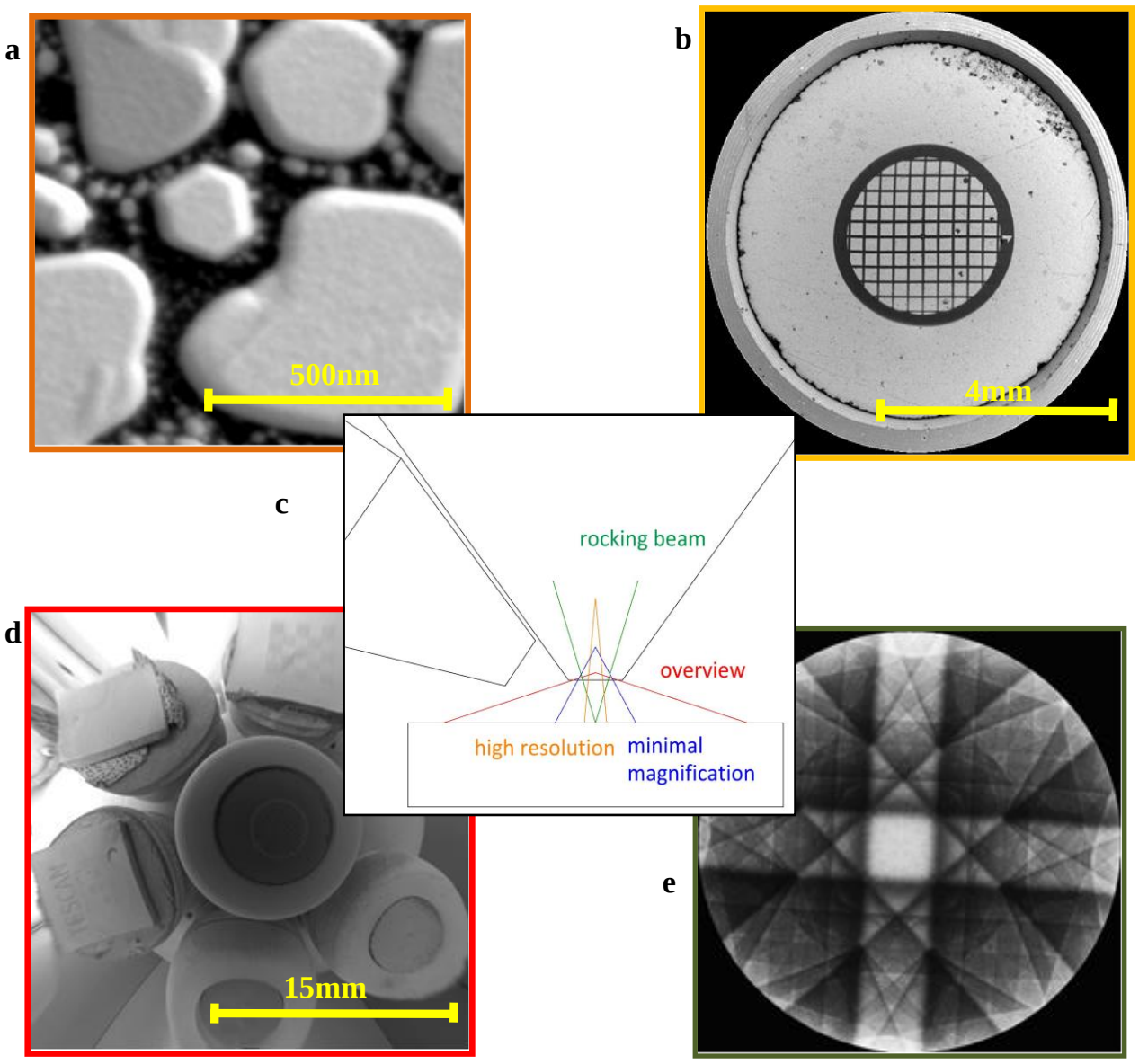

Figure 1. Flexible imaging with Wide Field Optics and combined magnetic-electrostatic objective lens (all images at working distance of 6 mm): a) high magnification image of gold on carbon at 1 kV, b) minimal magnification with optimized distortion at 1 kV, c) indicated positions of pivot point and beam deflection angles, d) a bit higher distortion is allowed for live sample navigation; field of view as large as 30 mm can be obtained at WD only 6 mm (image taken at 200 V), e) channeling pattern with rocking beam angle 8 degrees at 20 kV.

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