Scanning Alternative to the LEEM

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Scanning Electron Microscope (SEM) is widely used instrument for the observation of bulk specimens. Nowadays a resolution of 4 nm is available at 100 eV of the primary beam energy in a commercially available SEM [1], but at lower energies the resolution rapidly worsens. The only way how to keep high resolution down to very low energies is to use the principle of the Cathode Lens (CL), similarly as it is done in LEEM [2]. We tested this mode in several commercially available SEMs, and obtained experimentally the resolution of 9 nm at 10 eV, which corresponds to our theoretical results [3]. The principle of one of our adaptations is shown in Fig. 1. The CL consists of the specimen at a negative potential, which can be fluently controlled from zero to 10 kV, and of the anode at the ground potential. The anode is formed by the detector from a $YAG:Ce^{+3}$ crystal bored disc with the inner/outer diameters 0.3mm/10mm, which can be precisely aligned to the optical axis. Very high collection efficiency of the detector is secured because of the signal electrons being collimated to the optical axis by the CL field. The collection efficiency decreases at very low energies (to 50% at 1 eV) and the specular spot (00) is lost, but even so the dark field diffraction contrast can be obtained [4]. There is chance to acquire electrons transmitted through very thin foils near to zero energy where the inelastic mean free path increases again [5]. We tested this possibility and first images are shown in Fig.2. [6].

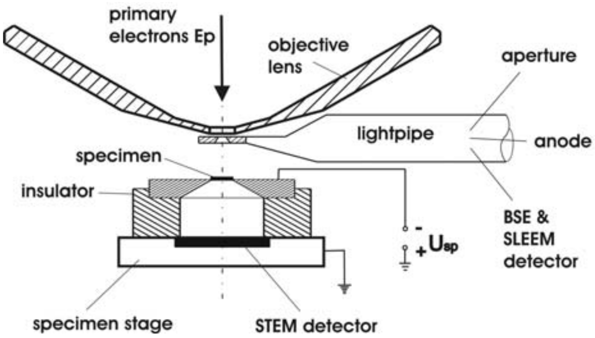

Fig. 1: *Scheme of the experimental set-up of an SEM equipped by the CL.*

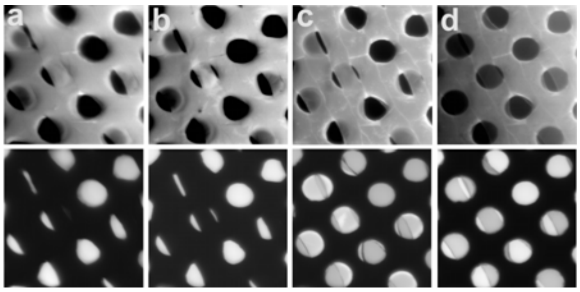

Fig.2: *Carbon foil (thickness 5 nm) lying on a copper grid of period 90 µm. Landing electron energies are a) 2 eV, b) 40 eV, c) 700 eV, and d) 3 keV. Upper row: SLEEM detector, bottom row: STEM detector.*

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[4] Frank L., Müllerová I., Faulian K. and Bauer E.: Scanning **21** (1999) 1-13.
[5] Hrnčiřík P. and Müllerová I.: G.I.T. Imaging & Microscopy **4** (2004) 47-49.
[6] The work is supported by the Czech Science Foundation under grant no. 102/05/2327.