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A New, Versatile, High Performance SEM

Ernst Jan R. Vesseur[1], Adrian Sandu[1], Petr Wandrol[2] and Doug Hahn[1]

1. FEI Company, Eindhoven, the Netherlands
2. FEI Company, Brno, Czech Republic

The quality of an image is determined by both resolution and contrast: the size of the features we can see and the type of information that the image gives about them. Recent advances in scanning electron microscopy have improved both, for example using magnetic immersion or electrostatic lenses for improved resolution, or by using in-lens, angle-sensitive detection for tunable contrast. Here, we introduce a new FEI SEM that presents a further improvement both in resolution and in contrast using a new compound electrostatic-magnetic final lens.

The SEM makes use of a combination of a magnetic final lens in the pole piece, a magnetic immersion lens and an electrostatic lens formed by the potential in the bottom of the column. The combination of these lenses focuses the primary electron beam to a very tight spot. The resolution of the system is specified as 1.0 nm at 1 kV. Figure 1 demonstrates the performance at 500 V landing energy.

The contrast performance of the system benefits from the in-lens backscatter detector (T1) located at a position close to the sample. The T1 detector receives a high signal intensity due to its position. This enables ultra-low beam current BSE imaging, as is shown in Figure 2. This is important for beam sensitive samples, such as polymers, porous materials or other fragile samples, which require the maximum amount of signal to be acquired in the shortest amount of time with the smallest dose possible. Furthermore, with the T1 detector BSE imaging is possible even during TV-rate navigation, so that materials contrast is always available, even when working at short working distance or with a tilted sample. Combined with the new compound final lens, the T1 detector is capable of acquiring an energy-filtered BSE image. Tuning of the lens strength allows for selective detection of low-loss BSEs. This enables precise materials contrast on the smallest particles, as also evidenced in Figure 2. Moreover, this energy selection works as an effective charge filter, allowing the acquisition of charge-free images on insulating samples. A low vacuum mode with chamber pressure up to 500 Pa completes the capabilities on charging samples, essential for analytical measurements on uncoated insulators.

The information that can be acquired from the sample is further increased by the use of detector segmentation. This is true for the T1 detector, which has two segments, but also for the retractable below-the-lens backscatter detector DBS, which has both 4 angular or 4 annular segments, which can be read out in any combination by selecting the desired mode in the software.

In conclusion, we present a new versatile SEM that brings a range of technologies including a compound final lens, BSE filtering, and segmented detection all into one tool. The system delivers the resolution and contrast that allows materials researchers to capture the maximum amount of information from their sample, with the right detail, with the least amount of work.

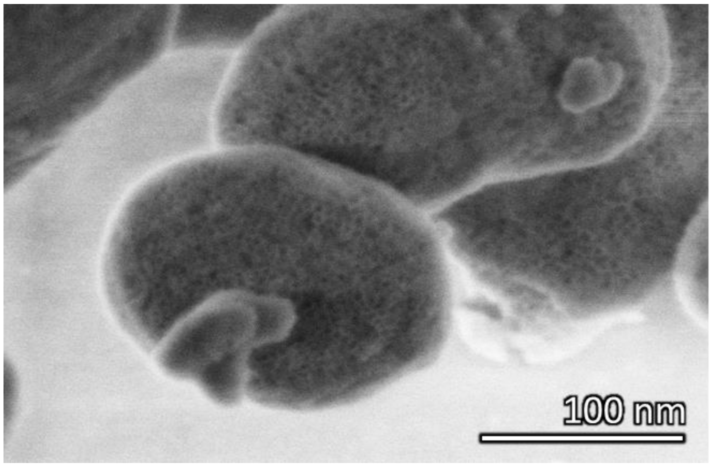

Figure 1. SEM image showing that with the compound final lens, the 2-nm-pores of mesoporous MCM-41 can be clearly resolved. Landing energy: 500 V.

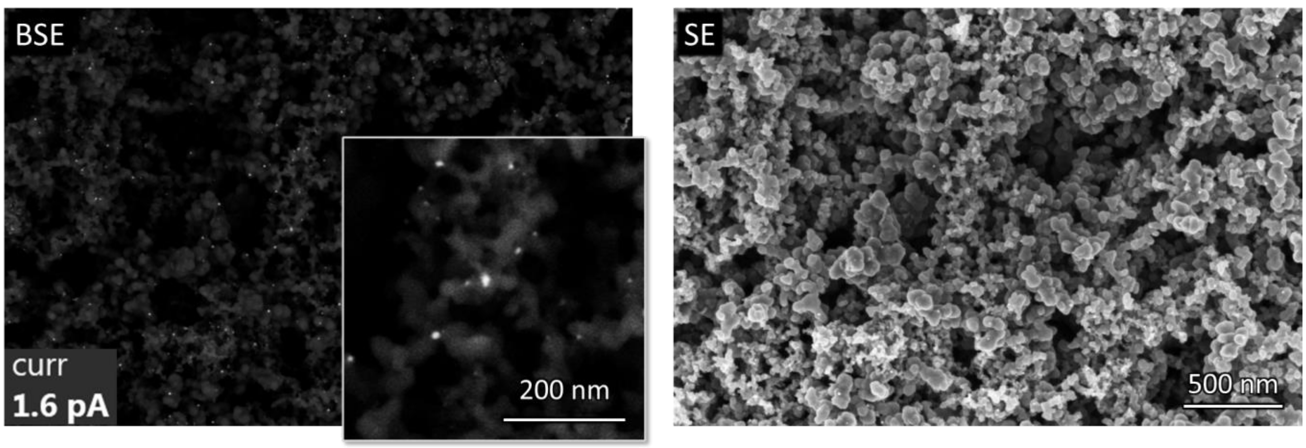

Figure 2. BSE and SE images of Pd nanoparticles on a CeO_2 matrix acquired at a very low beam current of 1.6 pA, showing clear materials contrast (left) thanks to BSE-filtered detection while a topographic image (right) is simultaneously detected. Landing energy: 1.5 kV.