SEM • TEM • SAMPLE PREP • MICROPROBES

What is Magnification?

Magnification can be a very deceptive number on SEM micrographs. As we all know, magnification is defined as the ratio of the size of the rastered area on the sample to the size of the rastered area of the output. Historically this been referenced to a Polaroid 4x5 film size. Today, no current SEM, including JEOL, uses this format. All images are collected digitally and output either as unprinted digital files, viewed directly on a PC display, sent via e-mail or printed via inkjet/laser jet type printers. A variety of software is used to handle this printing / display process (Photoshop, Paint, MSWord, FTP, Databases...). None of these have any specified print or display size. Therefore, only the ORIGINAL MAGNIFICATION (as referenced to 4x5) is meaningful. What is of paramount importance is the scale bar.

As an example, when a JEOL SEM takes a micrograph at 100,000X ORIGINAL MAG and we print it at ~4X5, the printed mag is ~100,000X. Others take that same micrograph at 50,000X. They then label the image as 100,00X and assume that it will be displayed and or printed at ~8X10 (or double the size of our print). They get a 100,00X image by enlarging the print. This allows microscope settings, which are much less stringent for magnifications that are 2 times lower. Lower mag allows the use of bigger spot size for better signal/noise, etc. It's also how it is possible to reach 900,000X with a W filament SEM even though 900,000X is a ridiculous number from the physics side.

What is required for comparing images is to compare the length of the scale bar, noting it's units, when the images are printed at the exact same size. This is true for any microscope image regardless of whether it comes from a conventional W SEM or a FEG.

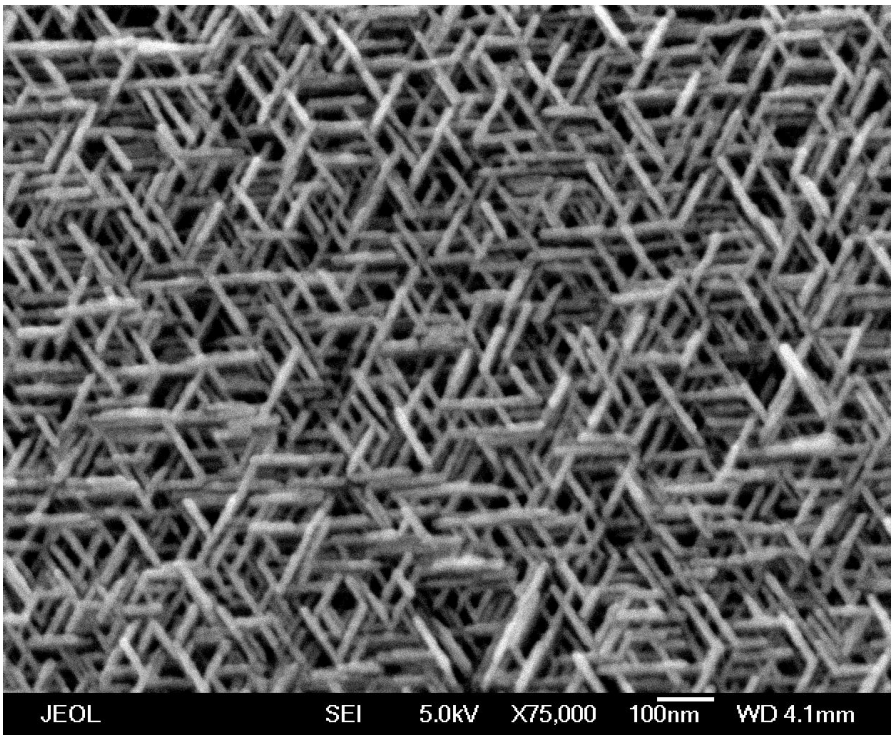

Fig. 1 JEOL SEM image of Hematite
Original mag and printed mag = 75kX, 100nm scale bar = 7.5mm

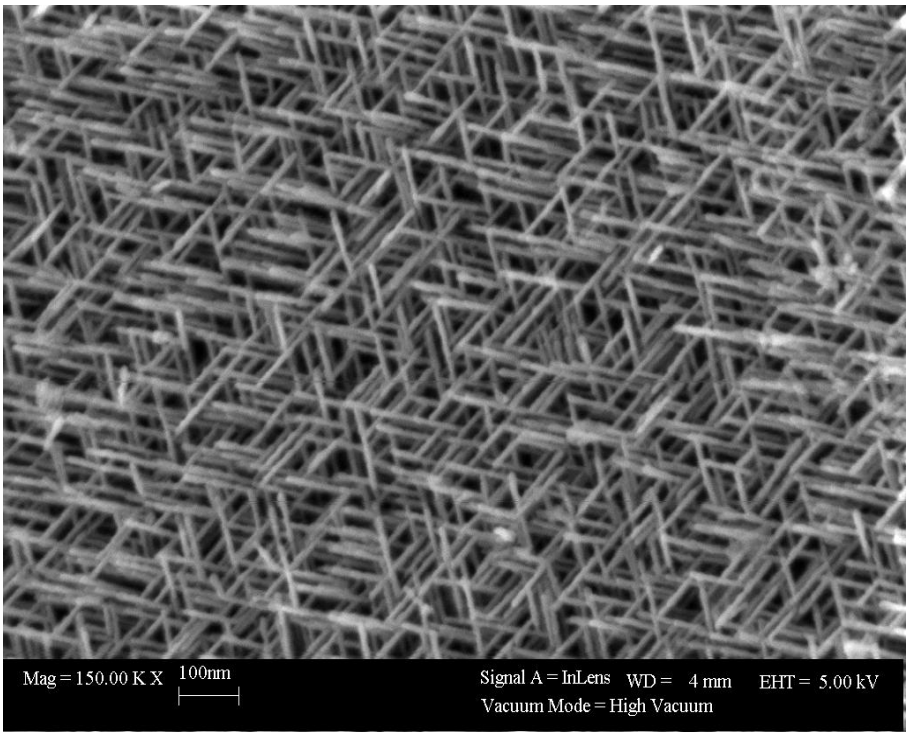

Fig. 2 SEM Image of Hematite
Original mag "referenced to" 8x10 = 150kX
but at the printed mag = 75kX, 100nm scale bar = 7.5mm

The images in Figures 1-3 illustrate this point. The images in Figures 1 and 3 are from a JEOL FEG SEM, and reference an original magnification for a 4x5 output and printed at that 4x5 size. Therefore the magnification number listed on the print is true. The image shown in Figure 2 is from another SEM manufacturer; where the original magnification is referenced to an 8x10 output. Therefore the actual magnification number as printed here (at ~4x5) is 75,000X or one half of the 150,000X as listed on the print. Note that the scale bar in both Fig1 and fig 2 are exactly the same length with the exact same units but the printed magnifications are quite different.

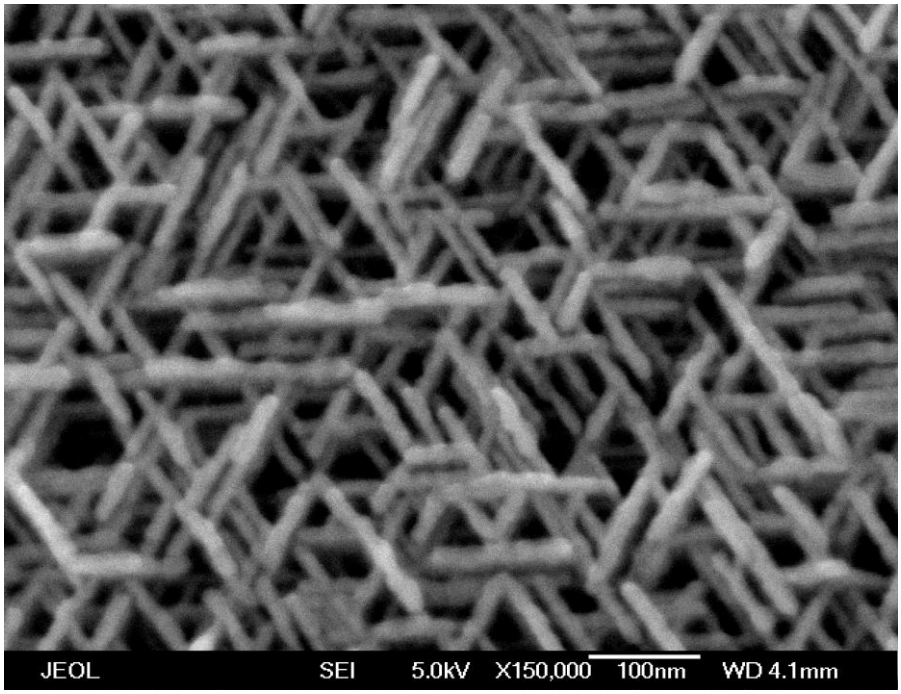

Fig. 3 JEOL SEM image of Hematite
Original mag and printed mag = 150kX, 100nm scale bar = 15mm