

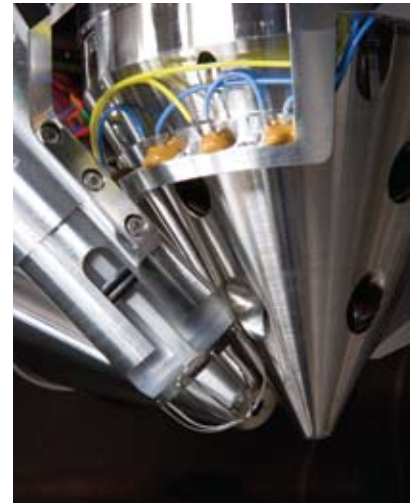


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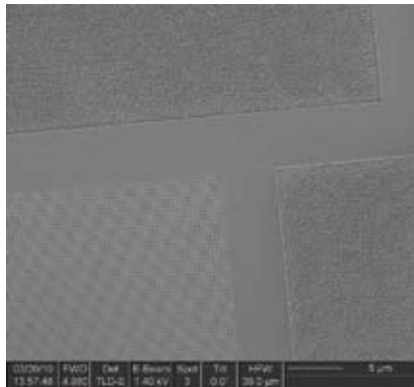


**AFM VS SEM : THE ULTIMATE FIGHT!**

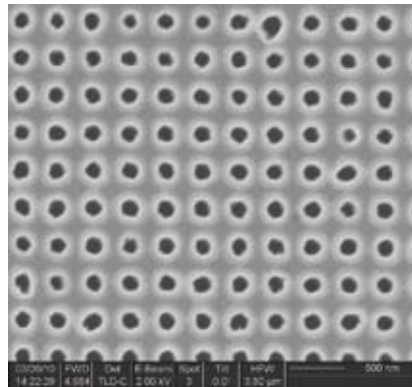
In the April newsletter ([http://www.gcmlab.ca/pdf/GCM\\_newsletter\\_no4.pdf](http://www.gcmlab.ca/pdf/GCM_newsletter_no4.pdf)), we have explained the working principles of Atomic Force Microscopy (AFM) and Scanning Electron Microscope (SEM) and we have discussed their strengths and weaknesses. This month, AFM and SEM engage in a fight involving the analysis of three different kinds of samples. Let the game begin!

**1st round: imaging of a photonic crystal**

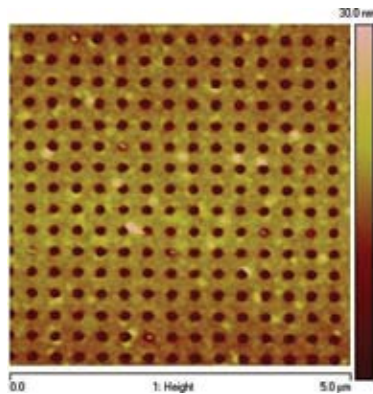
In this first round, AFM and SEM are confronted with a two-dimensional photonic crystal made of silicon nitride on a silicon substrate. This structure was fabricated by electron beam lithography and Reactive Ion Etching (RIE).



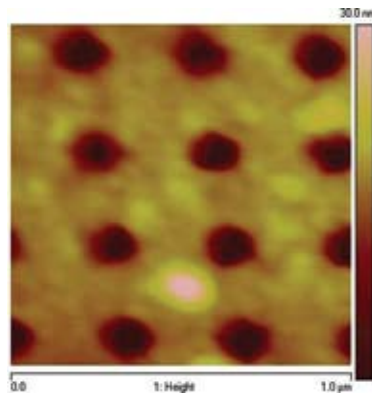
*Figure 1: SEM image of the spring arm that is used to hang the photonic crystal*



*Figure 2: SEM image of the photonic crystal (zoom of the lower left area of figure 1)*



*Figure 3: 5 µm x 5 µm AFM image of the photonic crystal*



*Figure 4: 1 µm x 1 µm AFM image of the photonic crystal*

In this first round, both SEM and AFM demonstrate their ability to resolve very fine details, such as the slight non-circular shape of the holes. However, SEM differentiates itself from AFM by its capacity to rapidly magnify the area of interest.



### 2nd round: imaging of an AFM calibration grid

This second round brings us on a ring where AFM is seen as favorite: the imaging of a silicon grid that serves to calibrate AFM in the X, Y and Z axes. The grid holes have a depth of 200 nm.

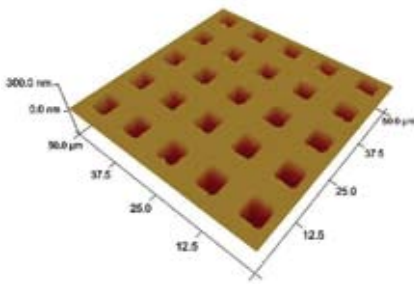


Figure 5: AFM image of the calibration grid

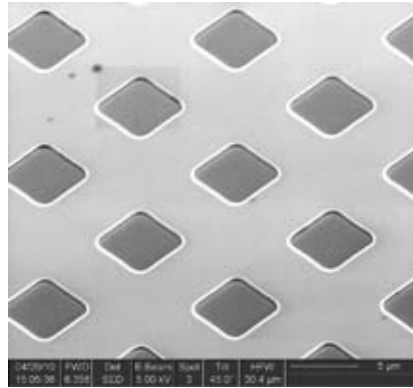


Figure 6: SEM image of the grid taken at a 45 degrees tilt

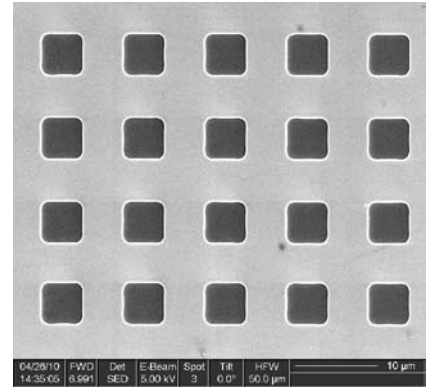


Figure 7: SEM image of the grid, perpendicular view

The punters who have bet on the AFM were right: AFM dominated this second round thanks to its capacity to image tridimensional structures, whereas SEM gives scant information on the sample topography. However, both methods showed a great performance in analyzing the lateral dimensions of the holes. Analytical tools can also evaluate the depth of the structures by compensating for the observation angle.

### 3rd round: imaging of a plasmionic nanostructure

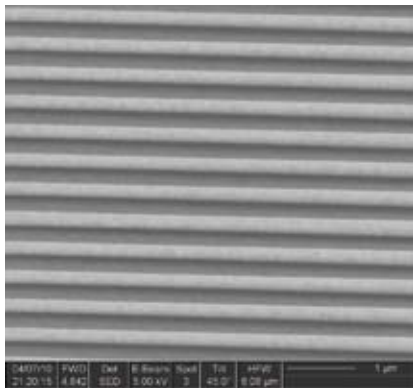


Figure 8: SEM image of the nanostructure

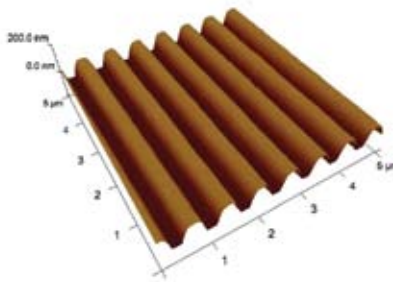


Figure 9: AFM image of the nanostructure

The third and last round involves the analysis of a nanostructure consisting of 300 nm-spaced gold barriers laid out in a pattern that takes advantage of surface plasmon resonance. The potential applications for this structure are very broad: amplification of spectroscopic signals, new types of lenses, optical filters, etc.

Like in the second round, the AFM tridimensional capabilities demonstrate a ruthless efficiency in this third round. We emphasize in figure 9 the sharp spatial and depth resolution of the AFM.

### Final score

This was an exciting fight that ended in a draw. AFM showed its strength to image vertical topographies whereas SEM offers a visual portrayal of the sample and a great flexibility for quick magnification. Both AFM and SEM have their own characteristics that make them more complementary techniques than competitive ones.

### Analysis by AFM and MEB

The GCM and its partner laboratories offer AFM and SEM analytical services for all kinds of samples.

### References and acknowledgements

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