

# **Project: Computer simulation of Physical systems**

Due on October 15, 2020

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The project will be done under the directives of Dr. Raphaël Butté, Senior Scientist and Mr. Pierre Lottigier Doctoral Assistant at the Laboratory of Advanced Semiconductors for Photonics and Electronics (LASPE). In the fabrication process, defects can happen. Indeed the position and the shape of the hole can vary due to fluctuations during the production. These defects have a strong impact on the quality of the resulting cavities.

The result of the etching process with which the holes are done can be controlled with high resolution Scanning Electron Microscope (SEM) images (see image 1).

The goal of this project is to update and improve the code controlling the quality of the nanobeam is controlled. The procedure that the code has to initially operate is the following :

- Sum the image along the axis perpendicular to the nanobeam, producing a vector  $v1$ .
- Locate the nanobeam edges by edge detection on  $v1$ .
- Extract the intensity along a line centered between the nanobeam edges, creating a vector  $v2$ .
- Estimate each hole's central position by extracting the positions corresponding to local minima of  $v2$ .
- Break the overall image into a series of sub-images  $I_j(x, y)$  of one photonic crystal period each; boundaries were at the nanobeam edges and perpendicular bisectors of the line adjoining adjacent holes.
- Determine the area belonging to the hole in sub-image  $I_j(x, y)$  through application of a binary threshold ( $I_{th}$ ).
- Compute the hole radius and position.

This is the base of the program to update, in addition to that, some of the content of the course will be added to optimize the code. For example, the implementation of holes' circularity analysis could also be investigated.

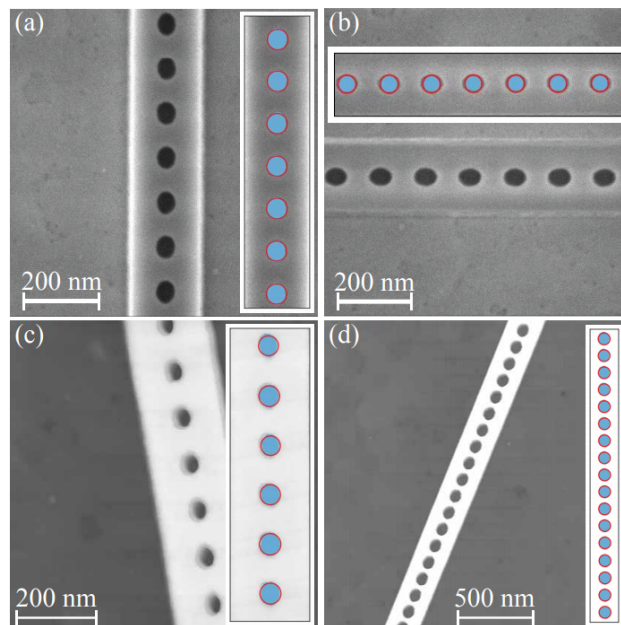


Figure 1: SEM images of a nanobeam [1].

Furthermore a similar code has already been done by Nicolas Villa of the SCI-SB-RH group, when the code is finished a comparison between the two methods will be done in order to improve the latter.

## References

- [1] Ian Rousseau, III-Nitride Semiconductor Photonic Nanocavities on Silicon.