OPTICAL LOSSES CONTROL BY FINELY TUNING THE DISTANCE BETWEEN A BRAGG MIRROR AND A 2D PC.

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We report on how the coupling of a Bragg reflector and a 2 dimensional Photonic Crystal (2D PC), by finely tuning the gap between them, can modify and enhance, the properties of the light emitted by SOI. Measurements pointed out a modulation of the extracted intensity as well as one of the quality factor (Q).

It will be very convenient to have, for future optoelectronic circuits, a light source made of crystalline silicon because of its wide use in the micro-electronic industry. But since crystalline silicon has an indirect gap it is a very poor light emitter and few report on emission from it[1]. We have studied how we can enhance the light emission properties of SOI by combining a Bragg mirror and 2D PC etched in the Si layer of a SOI wafer. The PC consists of a triangular lattice of Si rods and presents a slow group velocity mode at silicons' gap. The Bragg is made of quarter wave plate at 1.1µm. We have designed a piezo-electric set-up with which we were able to tune the coupling distance separating the Bragg and the PC at the scale of the wavelength. When we scanned this distance the recorded intensity showed periodic oscillations as depicted in figure 1. The period of these oscillations are half of the wavelength which is in agreement with 2D FDTD calculations. Results also pointed out a modulation of the quality factor of the structure as the mirror was taken away from the PCs' surface. Figure 2 shows these oscillations. The period of the Qs' oscillations is, just like for the intensity, half of a wavelength and is in accordance with 2D FDTD calculations. These two variations, with respect to the coupling distance, present the same period but are in phase opposition. When the intensity extracted is important the Q is weak as when the extracted intensity is low the Q is strong. This can be understood in terms of Fano[2] resonances as the optical mode interferes with the pseudo continuum of states of the space above the PC thus generating such resonances. As we move away the mirror we modify the pseudo continuum of states. As a consequence we change the interferences with the PCs' mode and Fano resonances. When the optical mode of the PC can couple to a Fano resonance (when interferences are constructive), losses are high, the Q is then weak and the extracted intensity important. In the other case interferences are destructive, the losses are weak, the Q is important and the extracted intensity low.

In conclusion we have designed and made a piezo-electric set-up enabling us to scan the gap between a Bragg mirror and a 2D SOI made PC at the scale of the wavelength. Results proved that by finely tuning this gap we could either enhance or deteriorate the intensity extracted from the PC as well as the quality factor. These results are in agreement with results studies on the coupling between Braggs and 2D PC[3,4].

References:

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Figures:

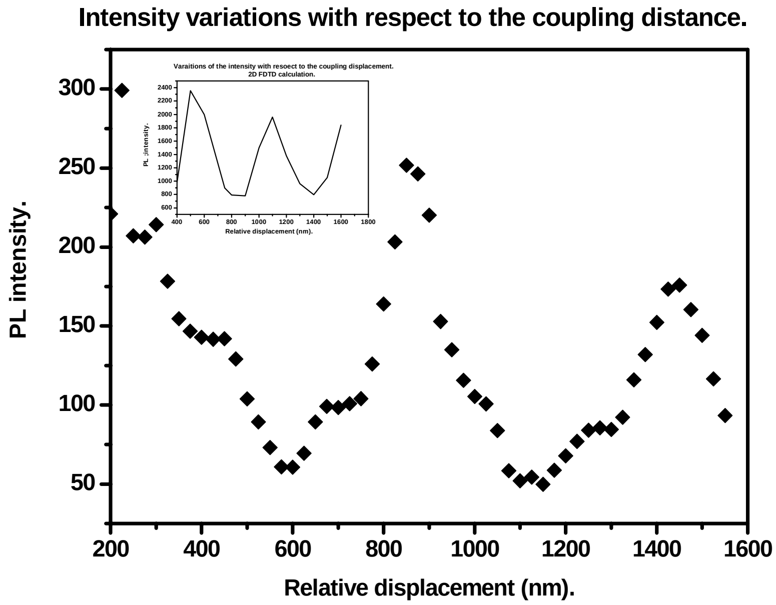

Figure 1 :Extracted intensity variations with respect to the air gap.

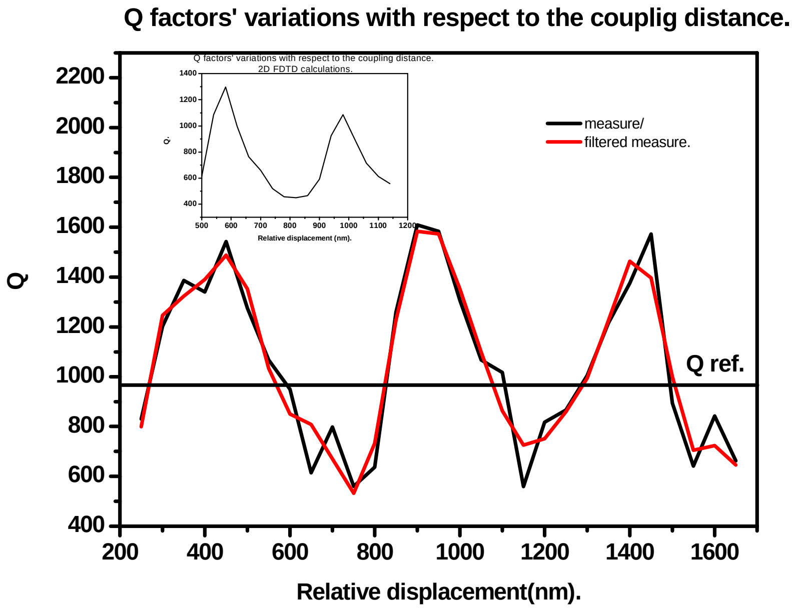

Figure 2 :Quality factor oscillations with respect to the air gap.