Amorphous Silicon Photonic Crystals made with 193nm lithography

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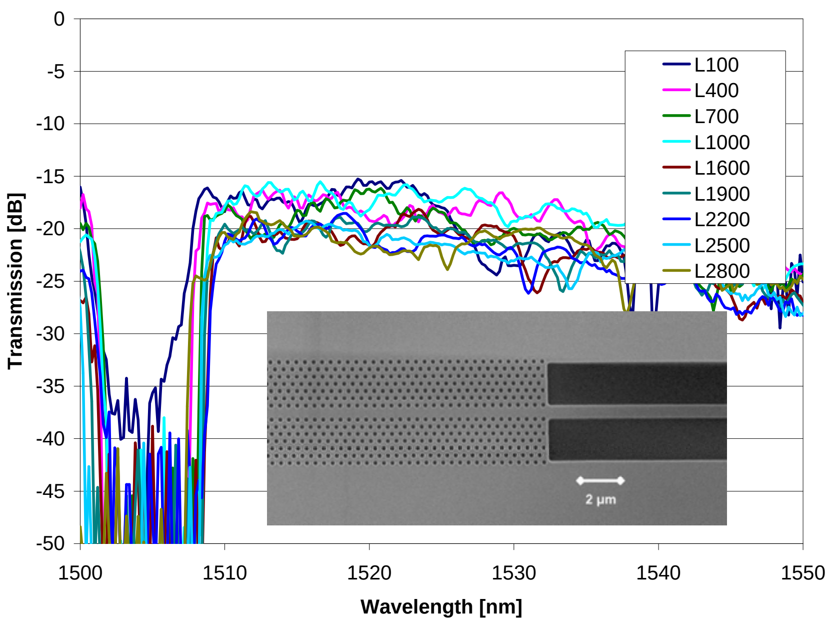
We present photonic crystal waveguides in amorphous silicon on insulator (SOI), patterned using standard 193nm projection lithography. Today, the most promising experiments with silicon photonic crystals have always been demonstrated with e-beam lithography. This technique offers extremely high resolution, but it is not well suited for larger circuits and large volume fabrication. The obvious alternative is optical lithography, as used for CMOS fabrication. This technique has already been used for photonic crystals, but with propagation losses significantly higher than with e-beam. However, we recently switched from 248nm to 193nm lithography with higher resolution [3], and better pattern uniformity [4]. Proximity effects are reduced from 40nm in 248nm lithography**Error! Reference source not found.** to the order of 4nm with 193nm lithography. The smallest lattice pitches we currently experimented with are 300nm.

Instead of crystalline SOI, we can also use amorphous silicon as a guided layer. The advantages are many: flexibility in layer thicknesses, cost of the substrate and the possibility of multi-layer substrates or circuits. However, amorphous silicon typically has a higher absorption. We have managed to deposit PECVD amorphous silicon films with a typical film propagation loss of 0.7dB/cm. The deposition temperature is 300°C, which makes it suitable for deposition on many substrates, including CMOS electronics. We fabricated the circuits on silicon with 2µm oxide, not unlike classical SOI.

For loss measurements we did not remove the oxide cladding. Instead, we applied a liquid coating with an index-matching fluid, resulting in almost the same optical properties as an deposited oxide top cladding. This way, we obtained an optically symmetric vertical layer structure. Transmission measurements were done using an LED light source and an optical spectrum analyser. Below we plotted the first transmission measurements for a photonic crystal waveguide with a pitch of 400nm and a hole diameter of 220nm. Various lengths, from 100µm to 2.8mm were measured. A clear stop-band can also be identified from the measurements. Outside this stop-band, propagation loss varies between -20dB/cm to -7db/cm, but further, more detailed analysis is required.



[1] M. Settle, M. Salib, A. Michaeli, Thomas F. Krauss, *Optics Express* **14**, pp. 2240-2245 (2006)
[2] W. Bogaerts et al., *Optics Express* **12**, pp.1583-1591 (2004)
[3] S.K. Selvaraja et al., *Leos Annual Meeting*, Lake Buena Vista, USA (2007)
[4] S.K. Selvaraja et al., *European Conference on Integrated Optics (ECIO)*, Eindhoven, The Netherlands (2008)

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