Focused ion beam for Photonics: A new versatile fabrication method

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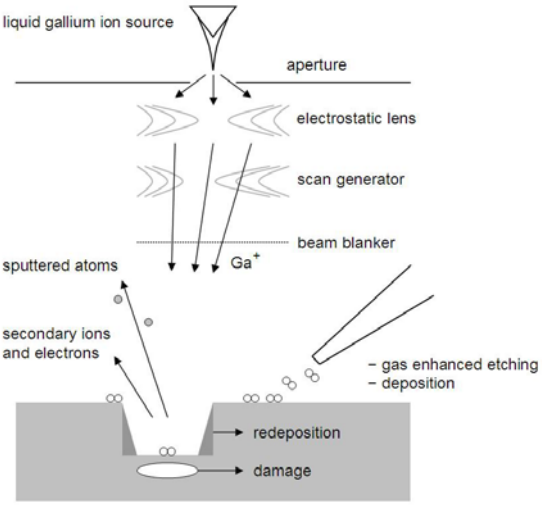
Idea

Lithography:

Even best and most expensive tools do not reach < 30nm resolution

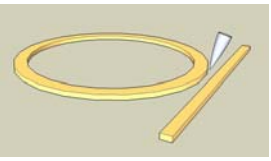
Focused ion beam:

- < 20nm resolution
- Fast and cheap prototyping
- 3D fabrication

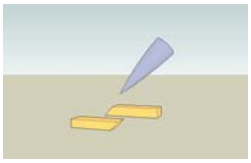


Nanophotonics:

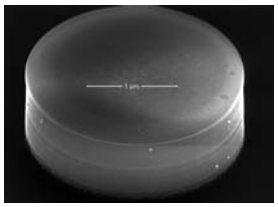
- Difficult to design (3D simulation)
- Nanometer fabrication precision required



Ring resonator tuning



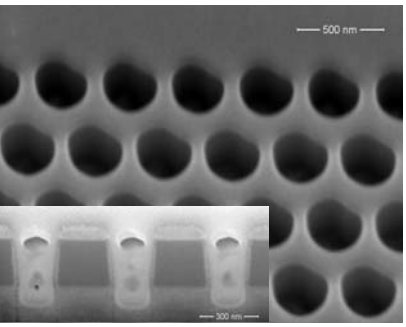
Slanted facet etching



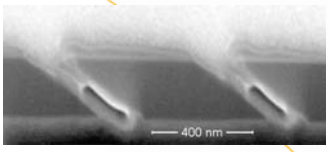
Micro disk laser prototyping

Problem

- Crystal damage
- Ion implantation
- Amorphization
- = **Optical losses**

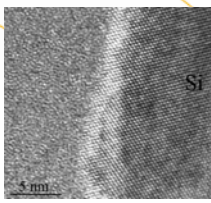


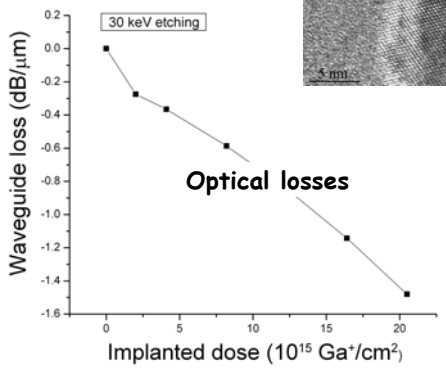
Photonic Crystal prototyping



Slanted grating fabrication

Silicon amorphization

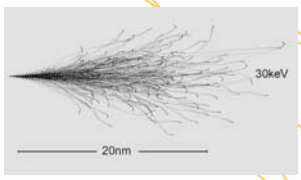




Solution

- Protective mask
- Etch enhancement gasses

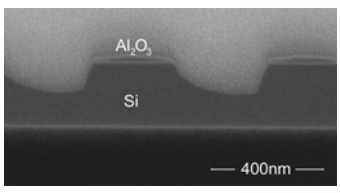
Al_2O_3 is resistant to Ga penetration



$Si + I_2 \rightarrow SiI_4$

Chemical reaction with iodine increases etch rate and causes less ion implantation en crystal damage

Successful fabrication of grating couplers for light coupling between optical chip and fiber



Outlook

- Recrystallization of Si and out-diffusion of Ga ions by annealing at high temperatures (> 800°C)
- Application of similar processes to III-V semiconductors

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