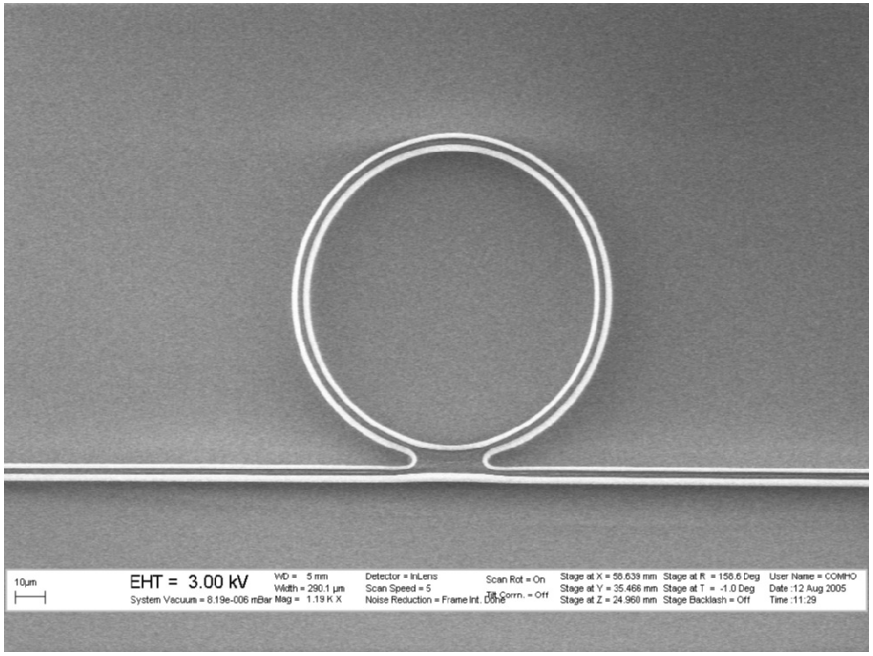
Novel Deep Glass Etched Microring Resonators Based on Silica-on-Silicon Technology

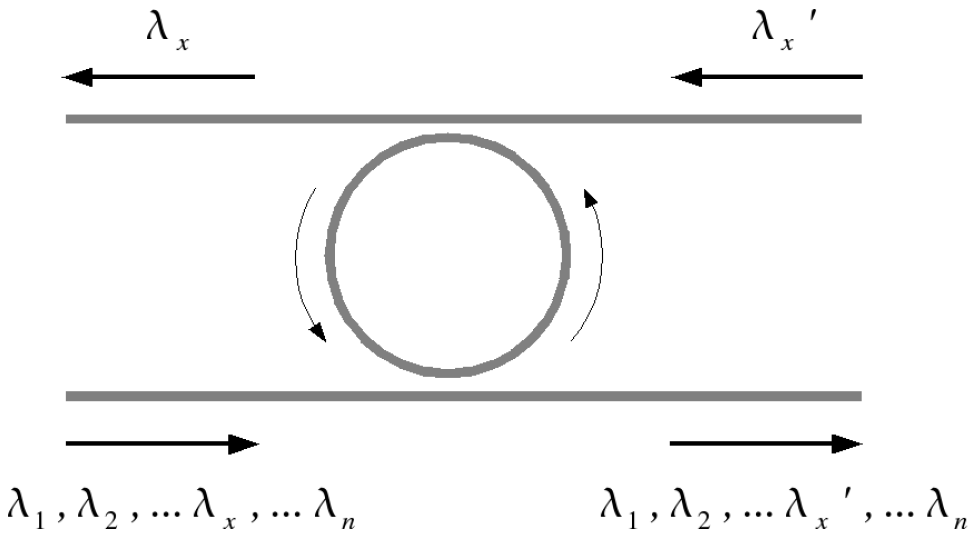


Haiyan Ou[1], Karsten Rottwitt[1], and Hugh Philipp[2]

1 : COM, Technical University of Denmark, 2: now at LASSP, Cornell University

Ring Resonators

- Compact.
- Simple Structure.
- Ideally non-reflective.
- Need sharp bends to implement ... high-index contrast.



Simple single ring add-drop filter

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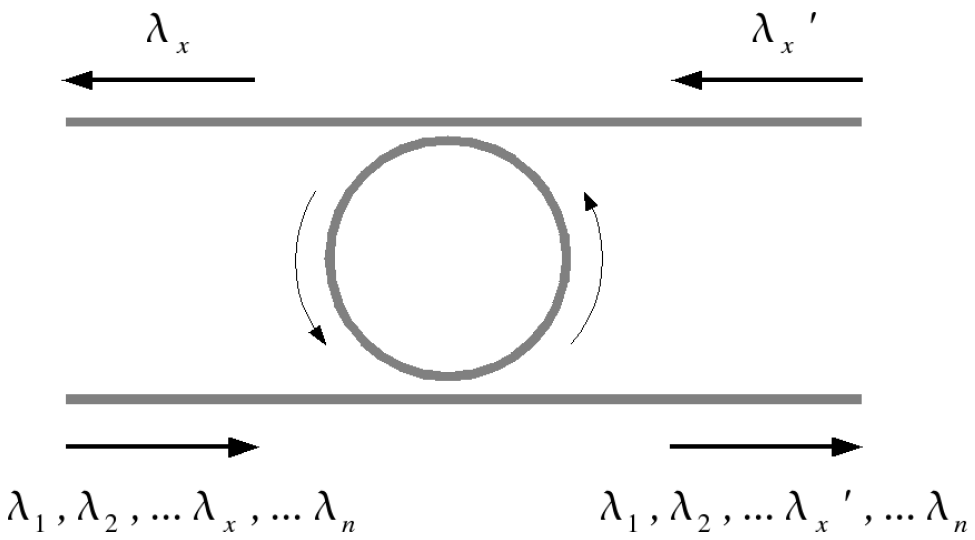

Simple single ring add-drop filter

$$Free\ Spectral\ Range = FSR = \frac{\lambda^2}{2\pi R n_g}$$

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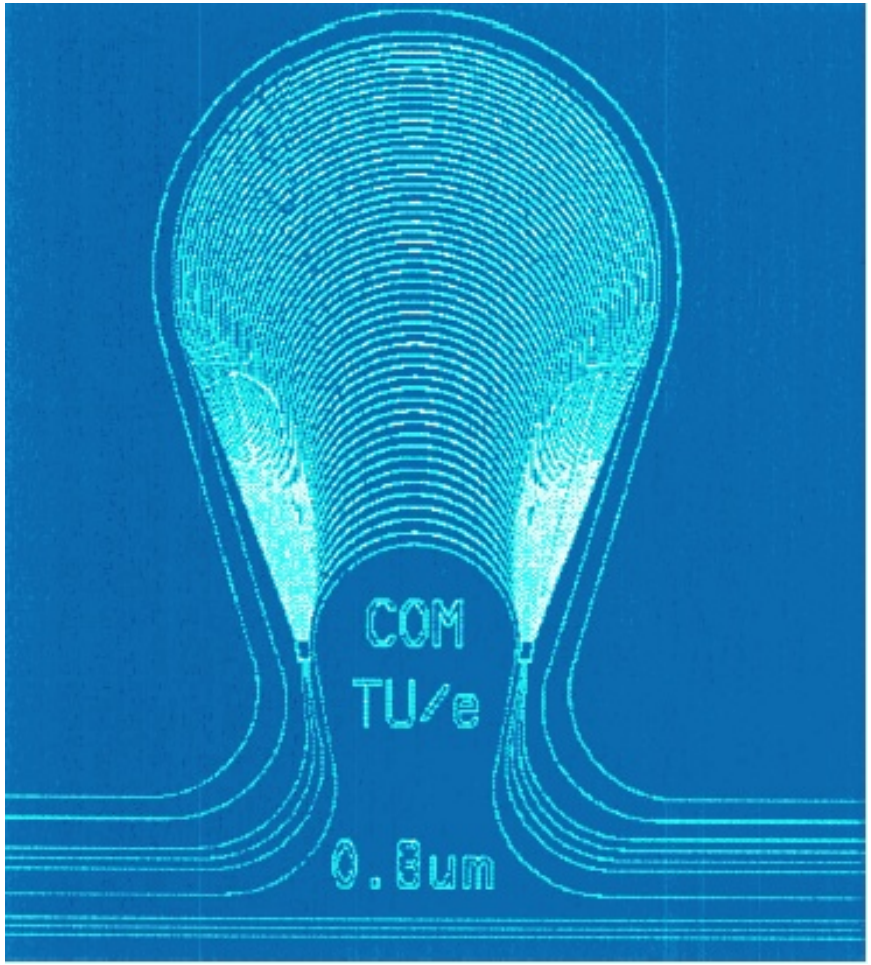
Silica-on-Silicon Technology

- Established waveguide technology.
- Index contrast of

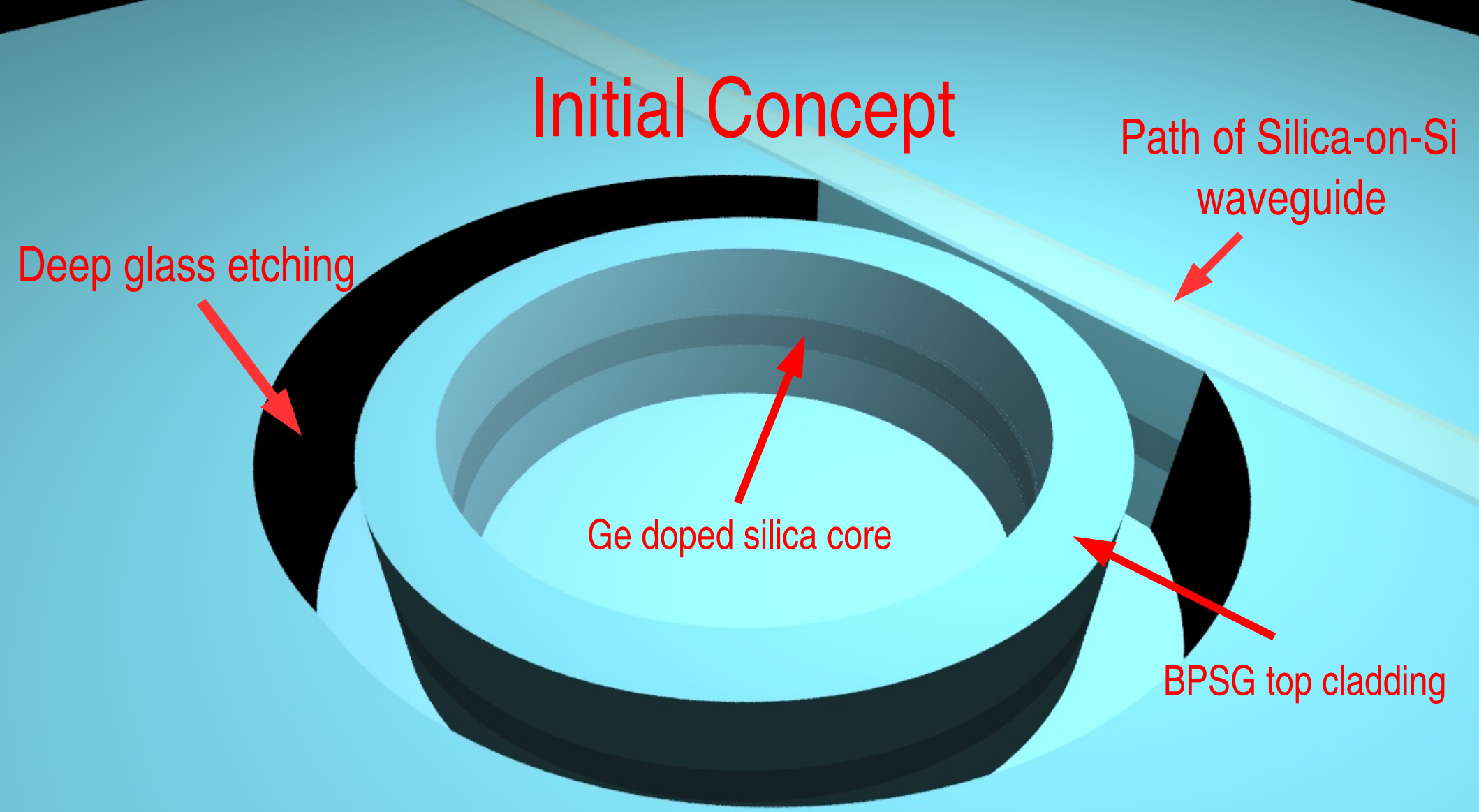
$$\Delta n \sim 0.01\text{-}0.02$$

- Low-loss bends for bend radii greater than a few millimeters.



Ref: Christian Mikkelsen

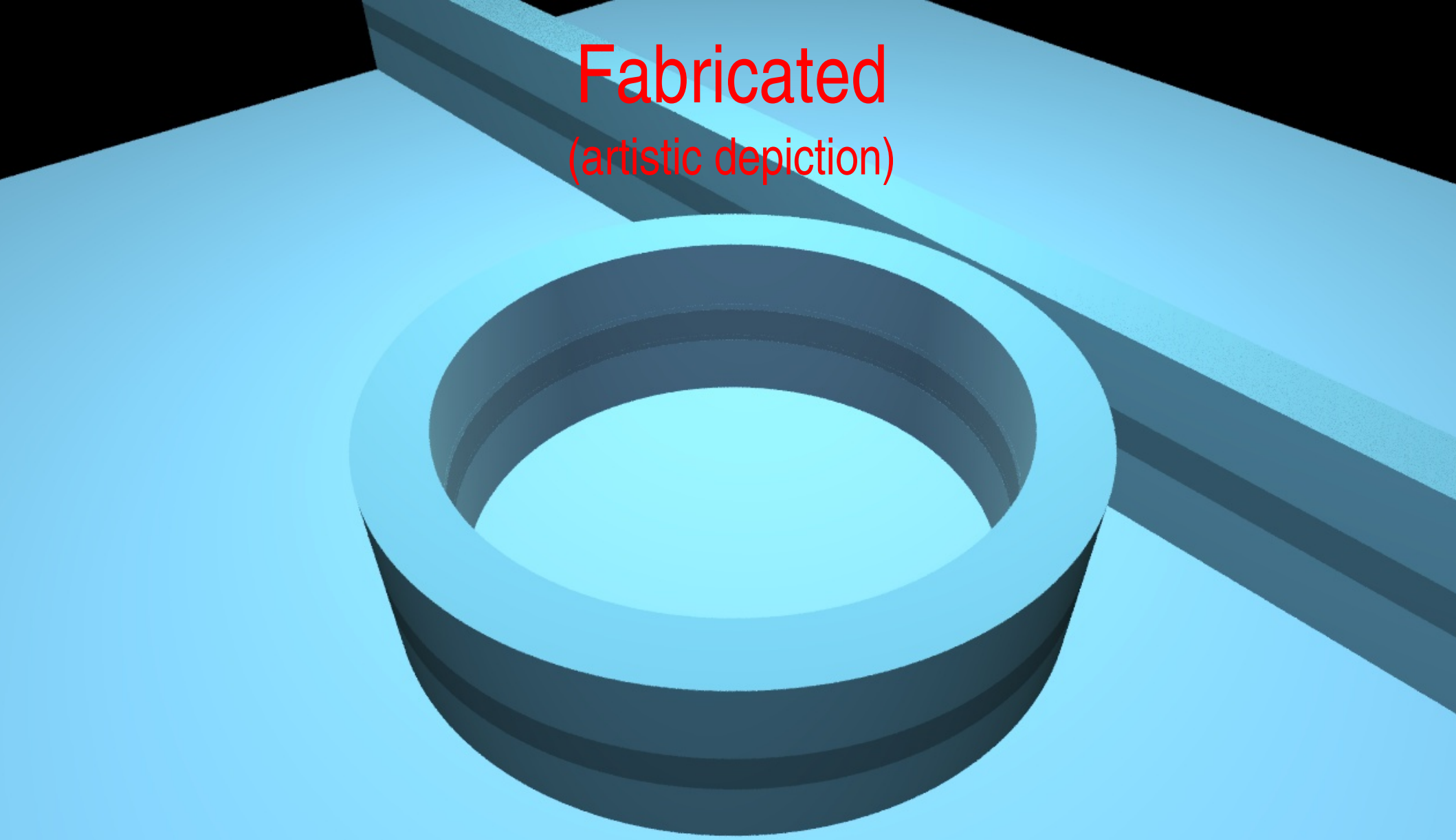
Initial Concept



- Use deep-glass etching to selectively make high-index contrast in silica on silicon technology.

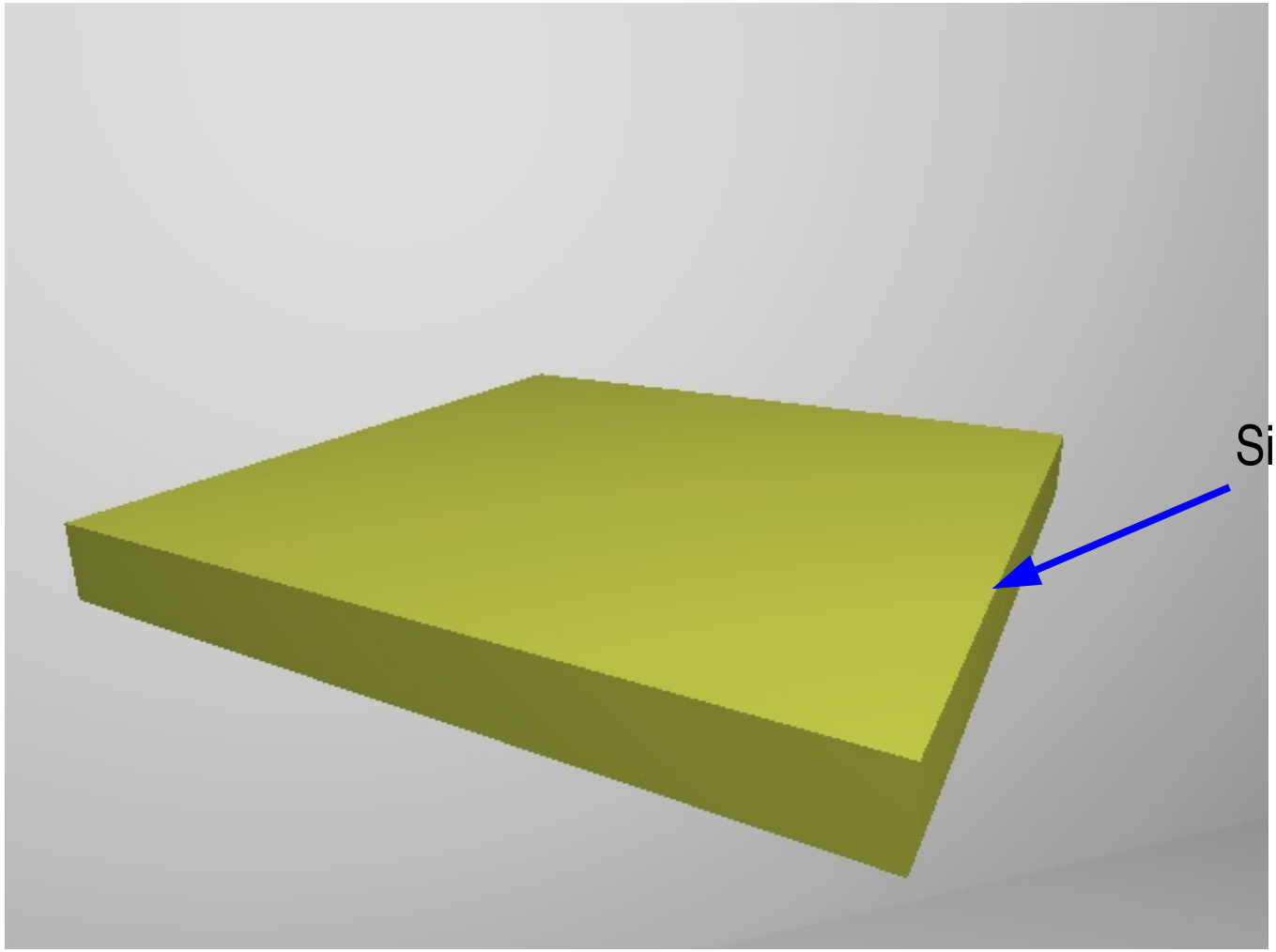
Fabricated

(artistic depiction)



- Easier to make... and tests basic concept.

Process Flow Diagram



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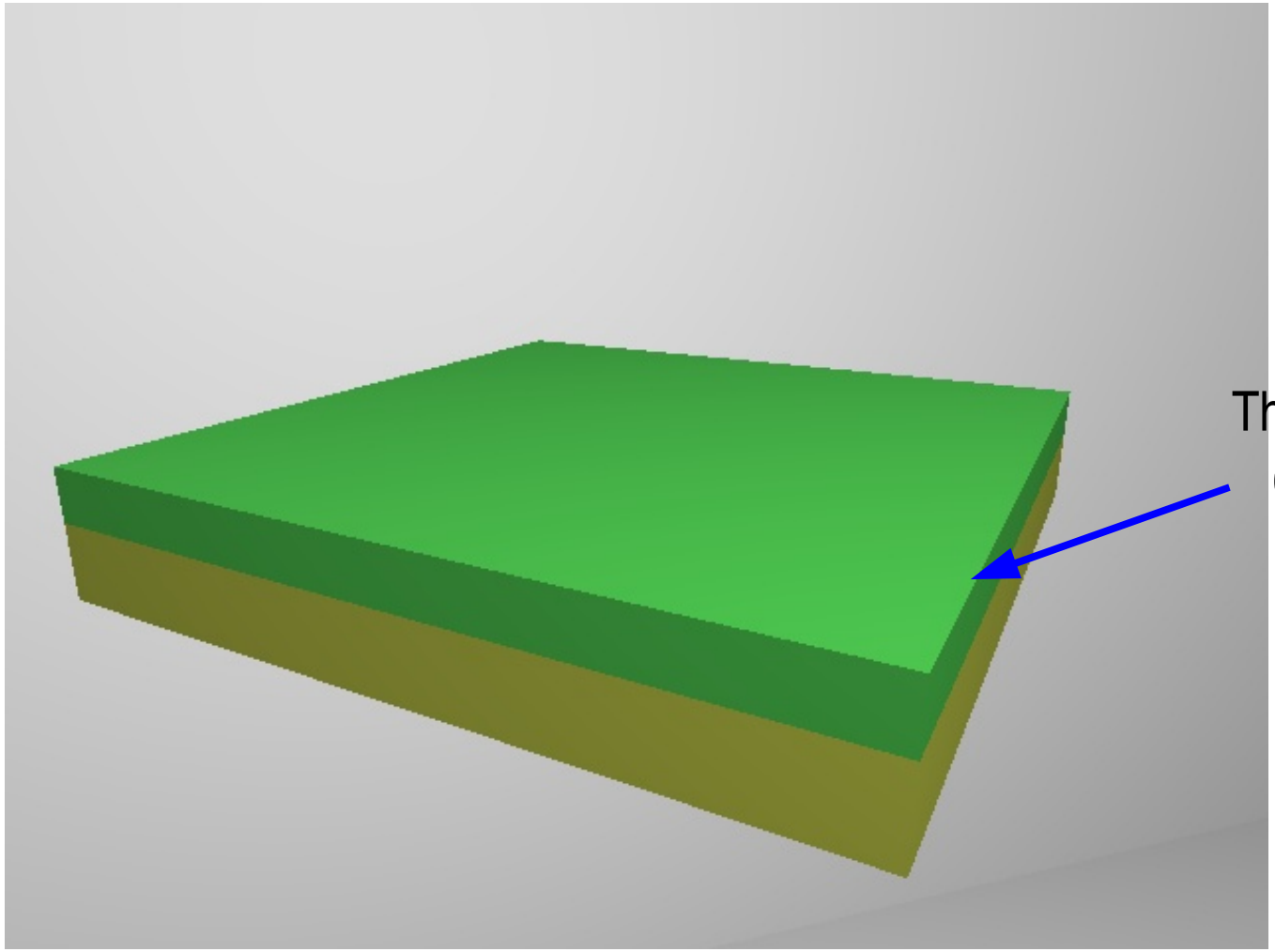
Process Flow Diagram



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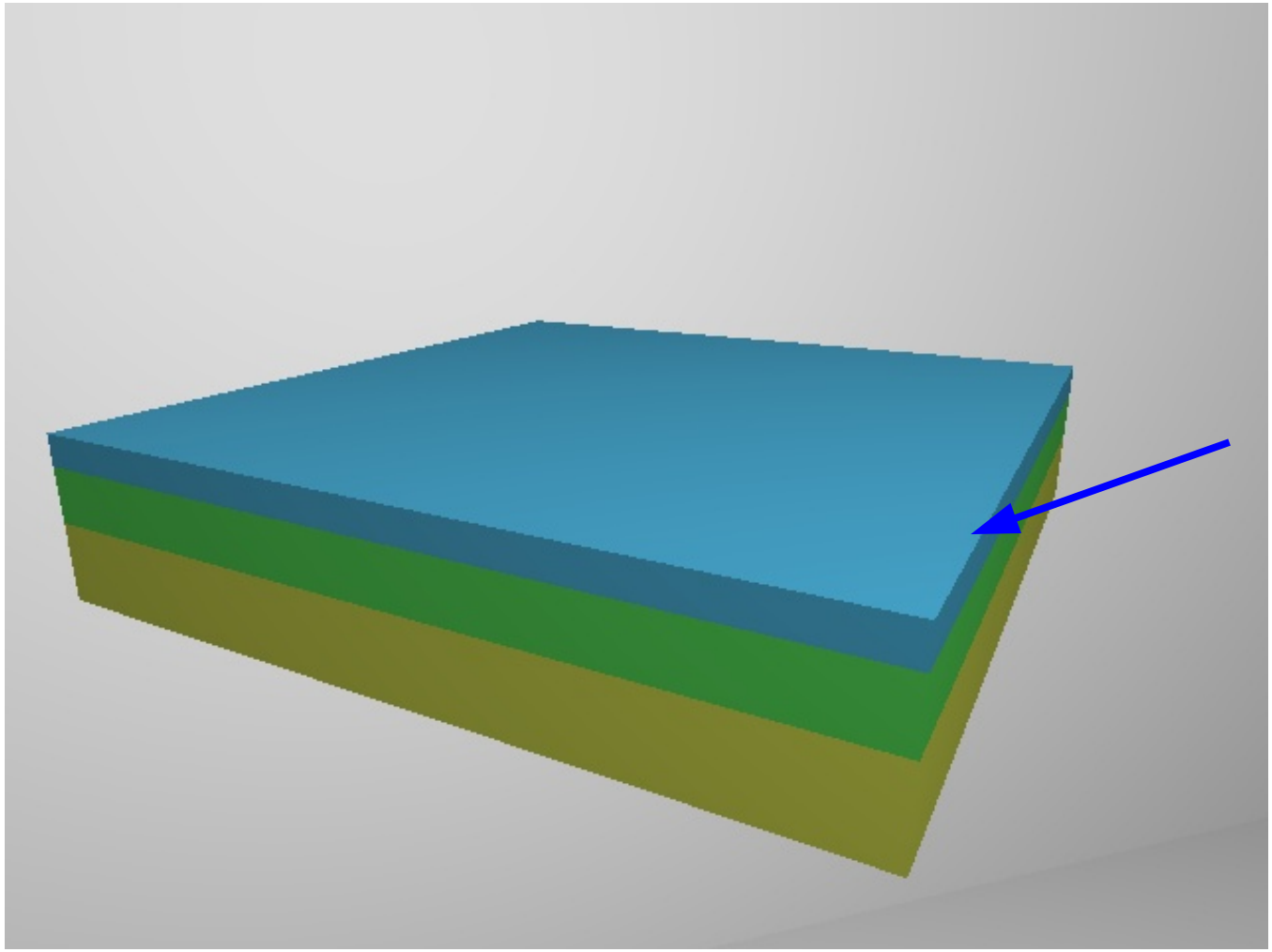
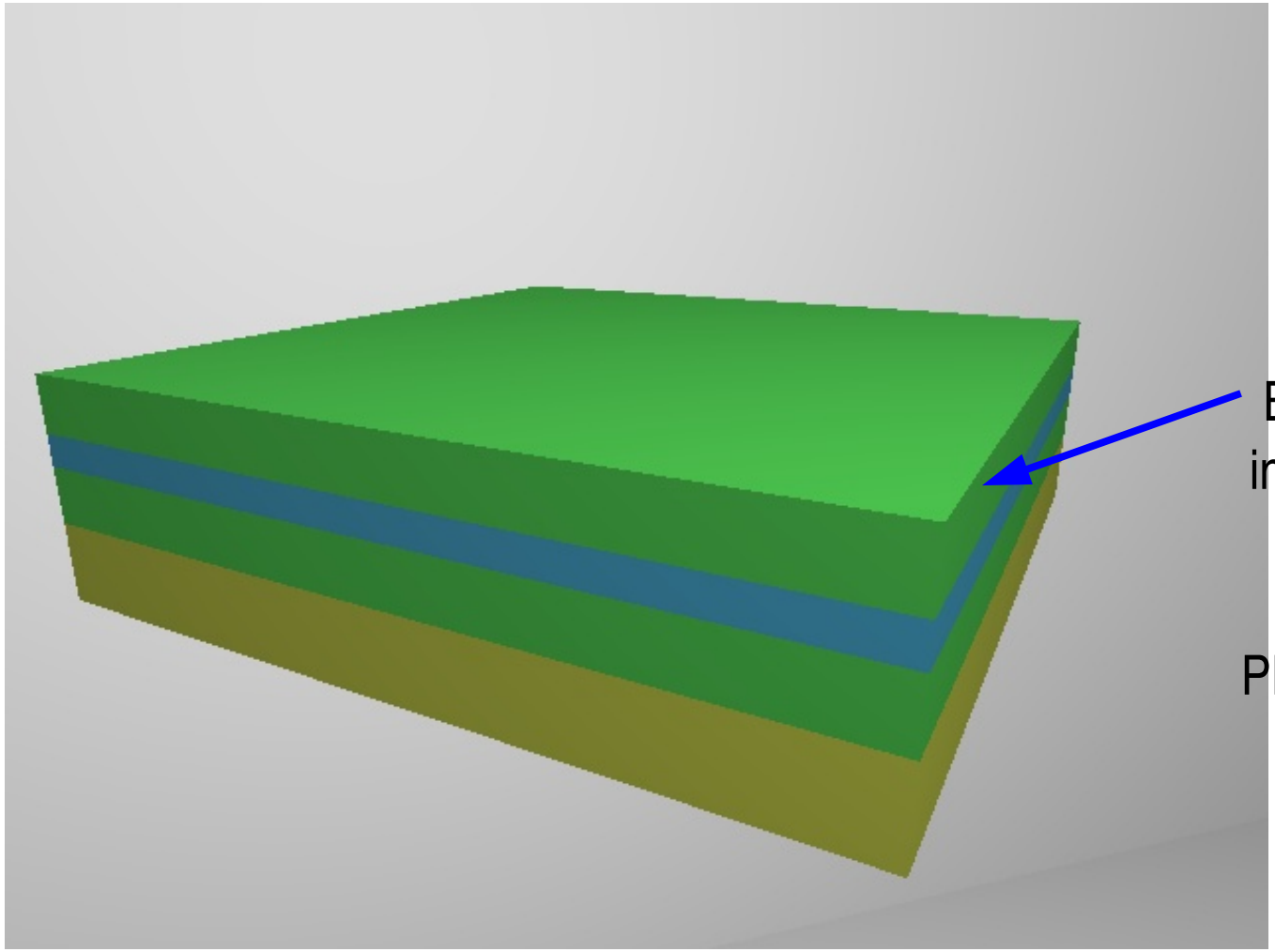
Process Flow Diagram



Ge doped Silica
$\Delta n = 0.02$

PECVD deposition
3.5 μm thick

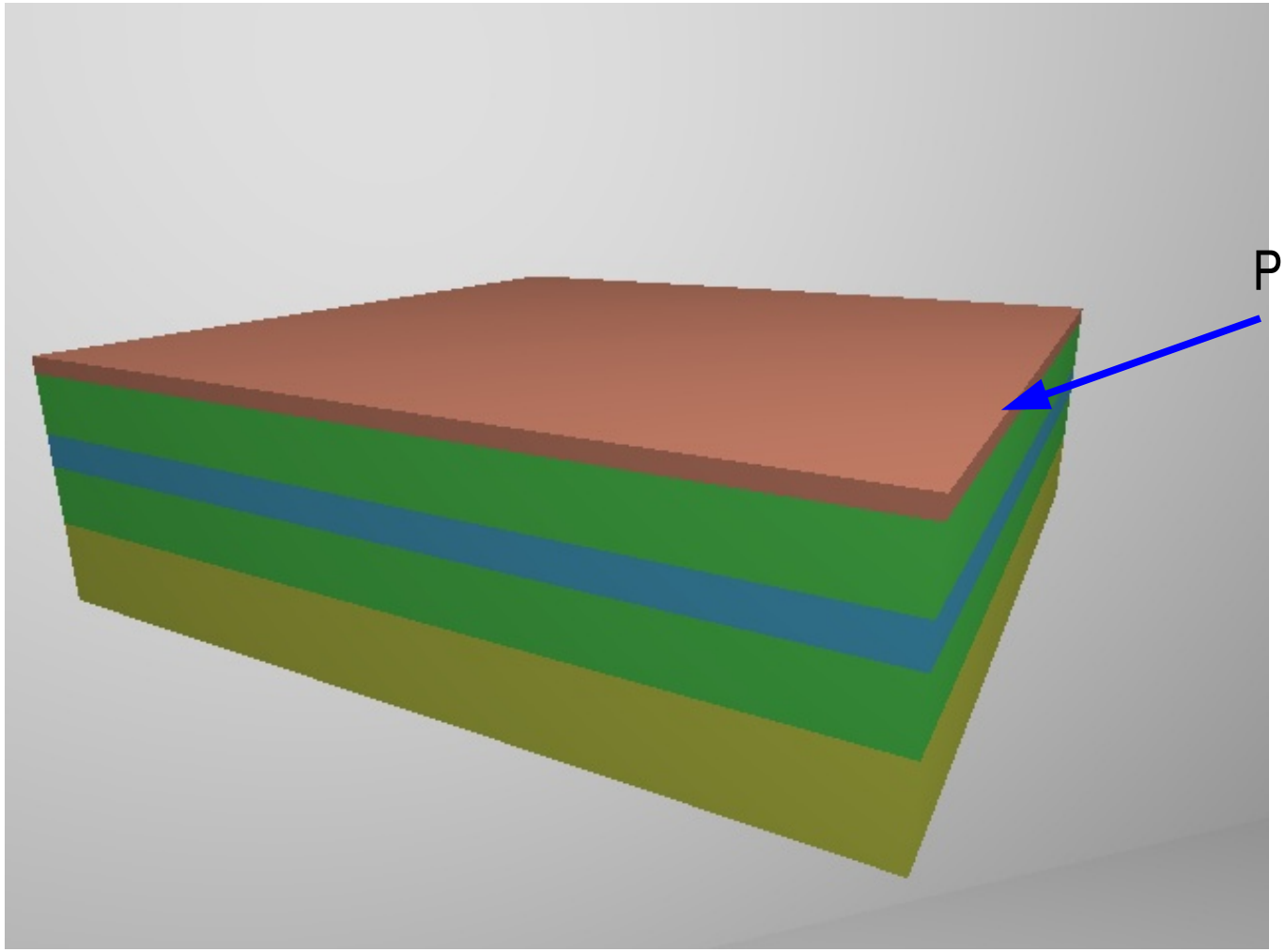
Process Flow Diagram



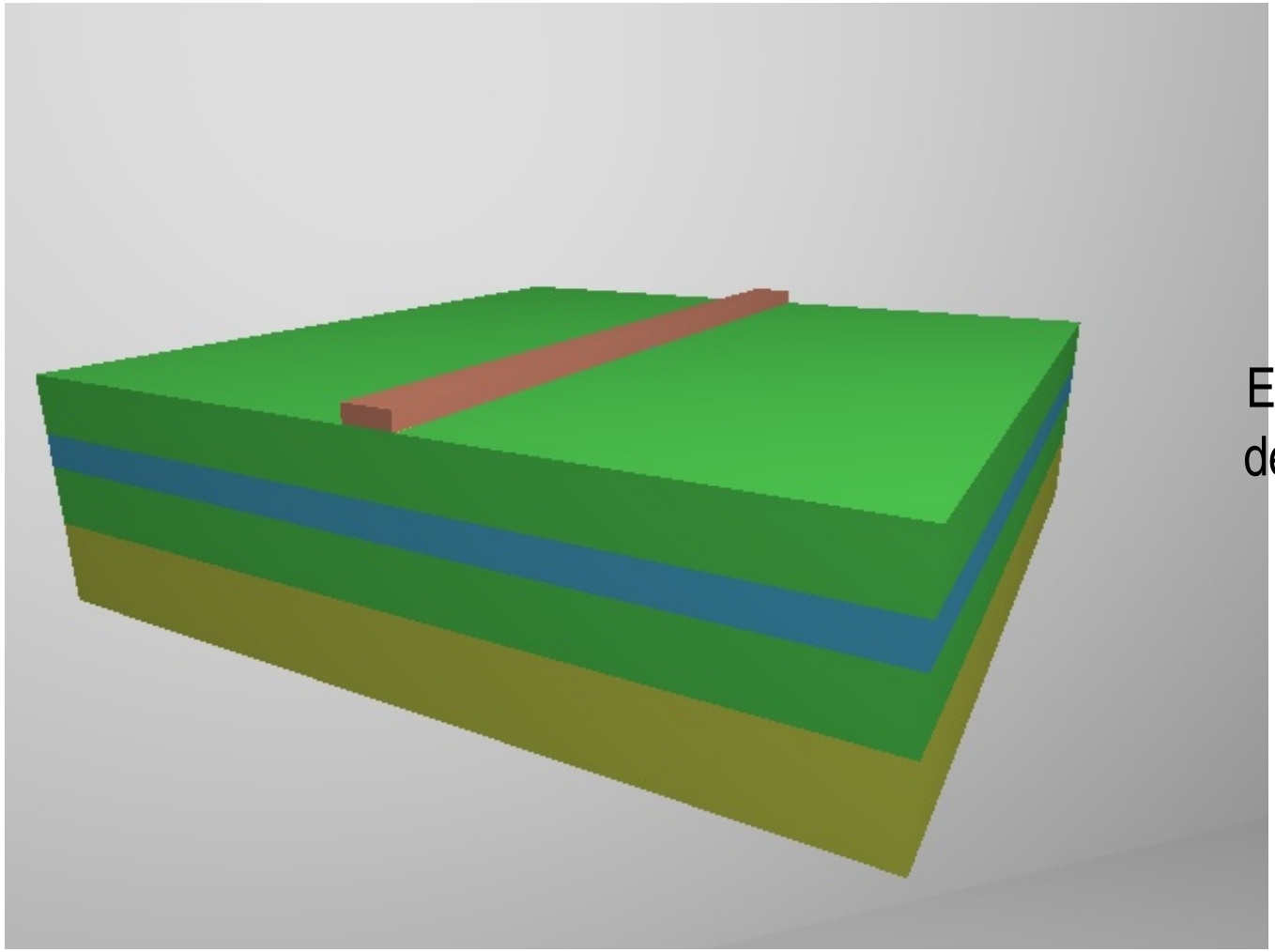
Top Cladding
B,P doped glass
index matched to
oxide

PECVD deposition
6 μm thick

Process Flow Diagram



Process Flow Diagram



Exposure and development...

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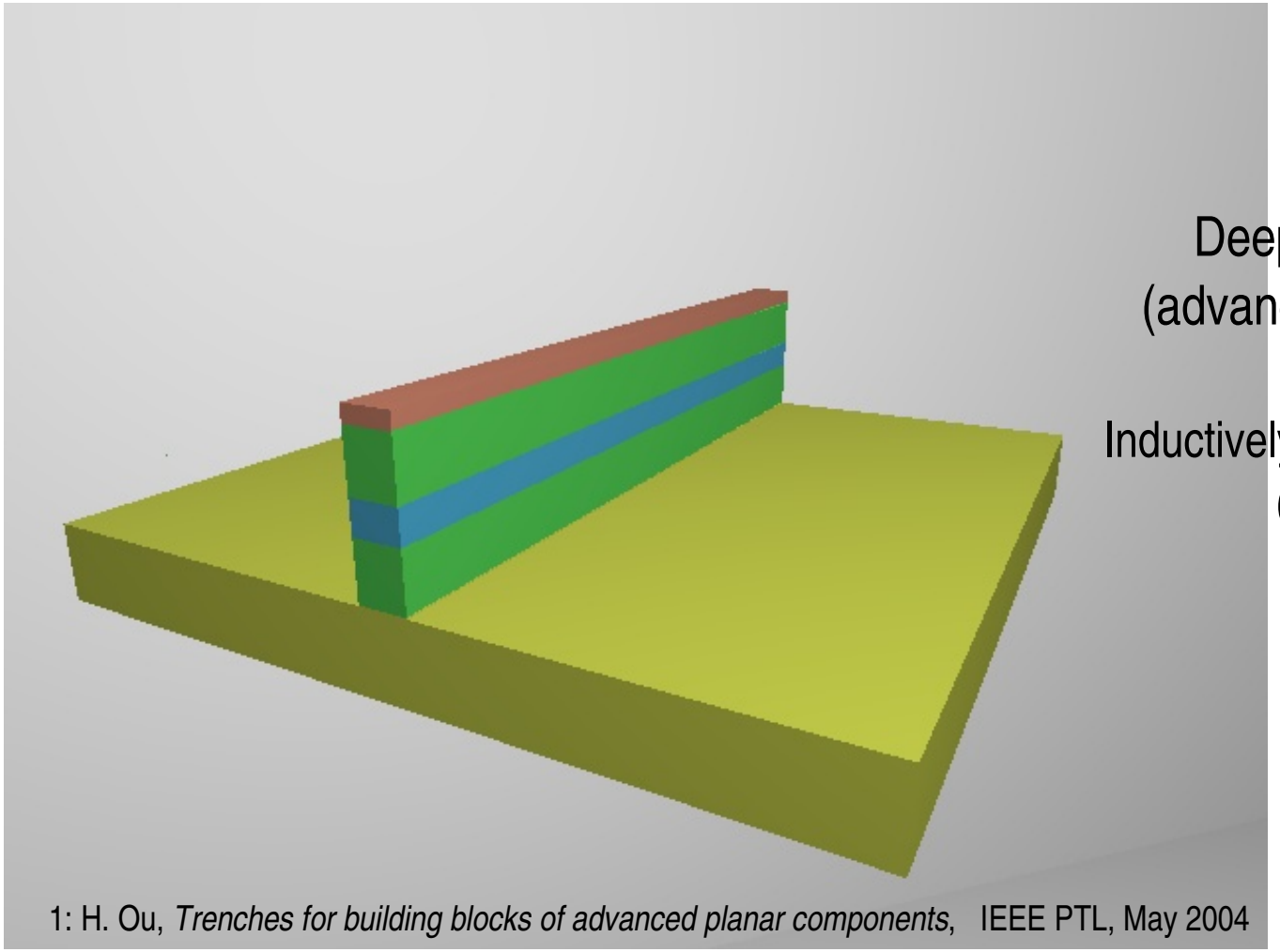
Process Flow Diagram

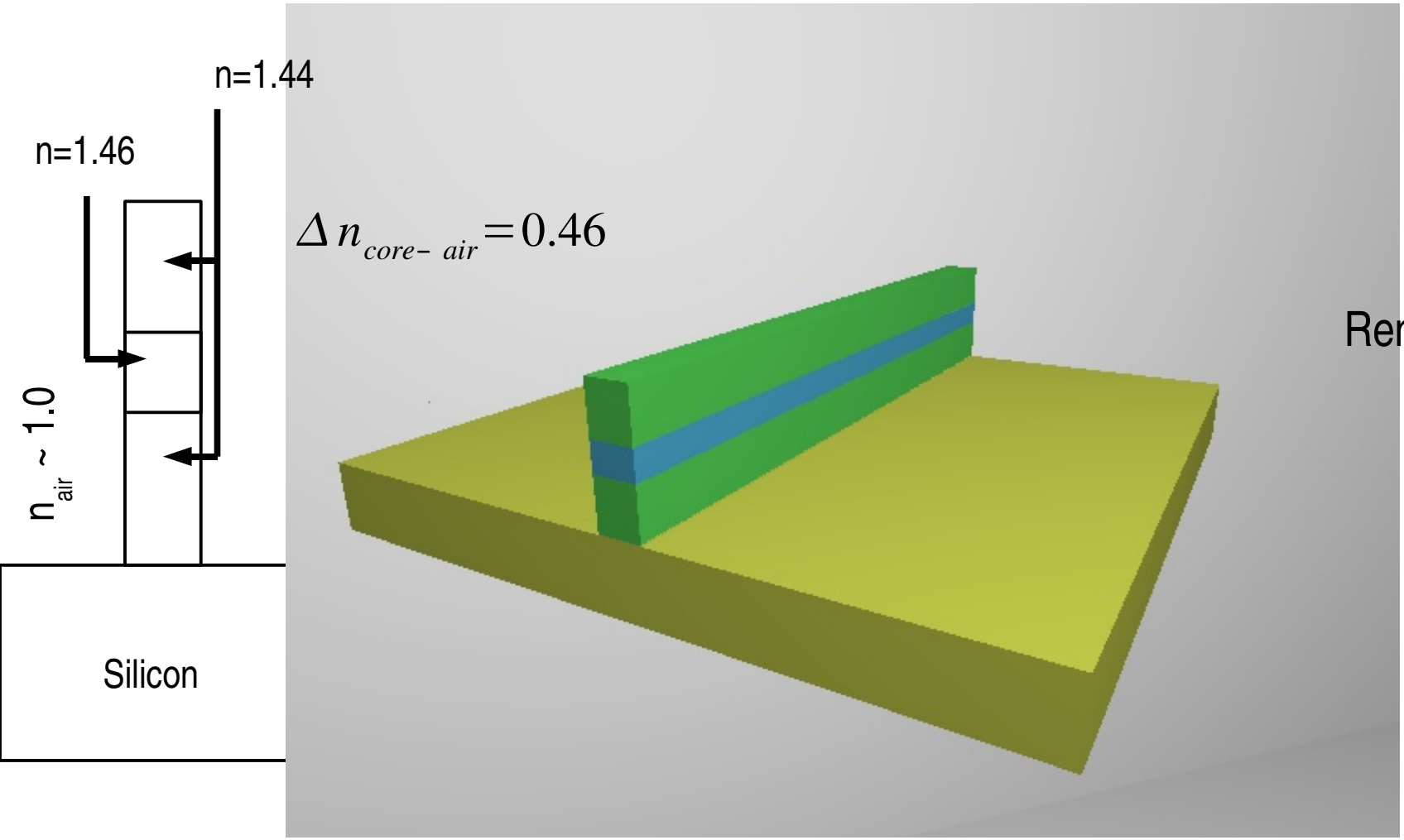


1: H. Ou, *Trenches for building blocks of advanced planar components*, IEEE PTL, May 2004

Deep Glass Etch
(advanced oxide etch)

Inductively Coupled Plasma
(ICP) etch

Process Flow Diagram



Remove photoresist

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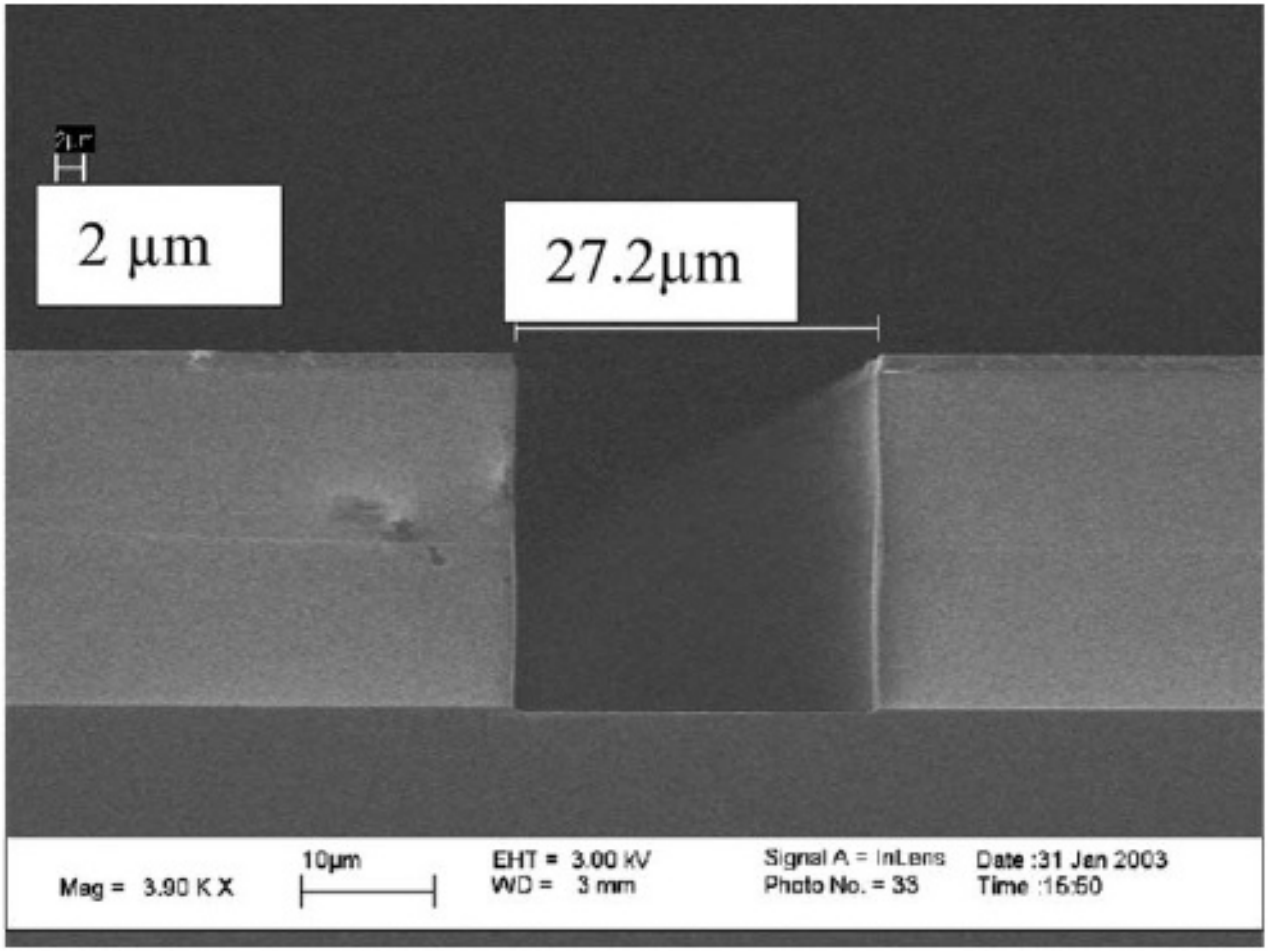
Deep Glass Etching



- Capable of high aspect ratio oxide etches.

1: H. Ou, *Trenches for building blocks of advanced planar components*, IEEE Photonics Technology Letters, May 2004

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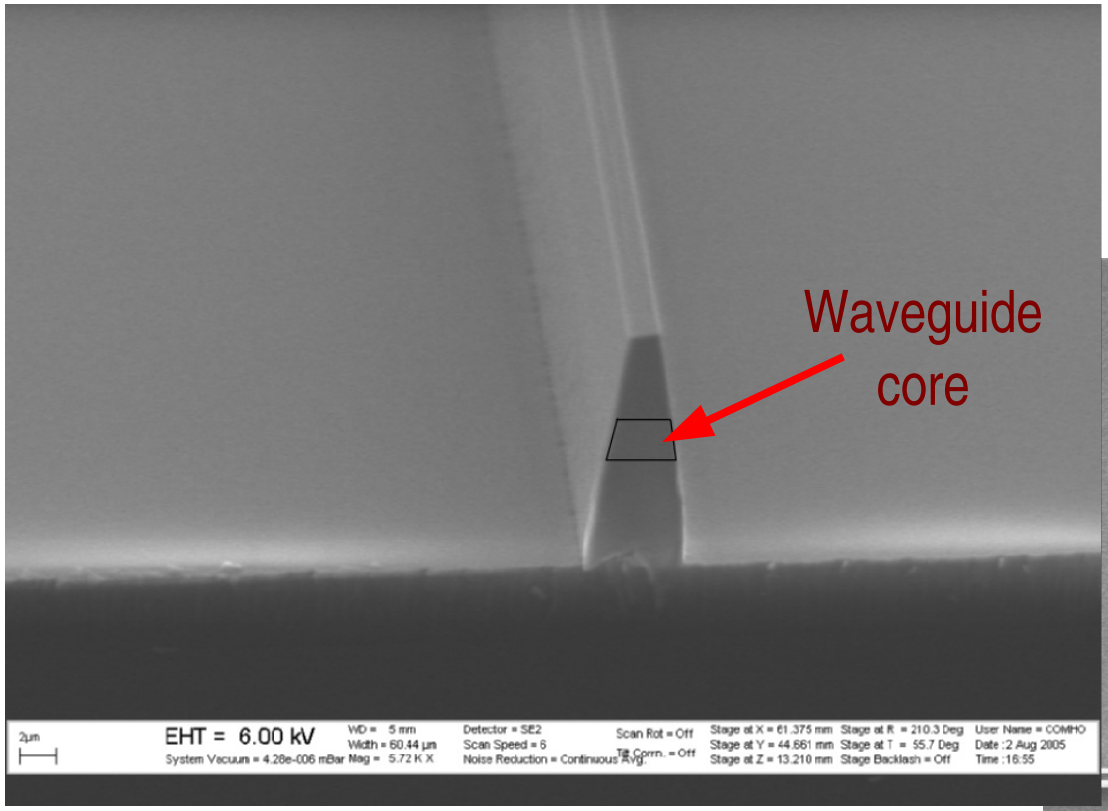
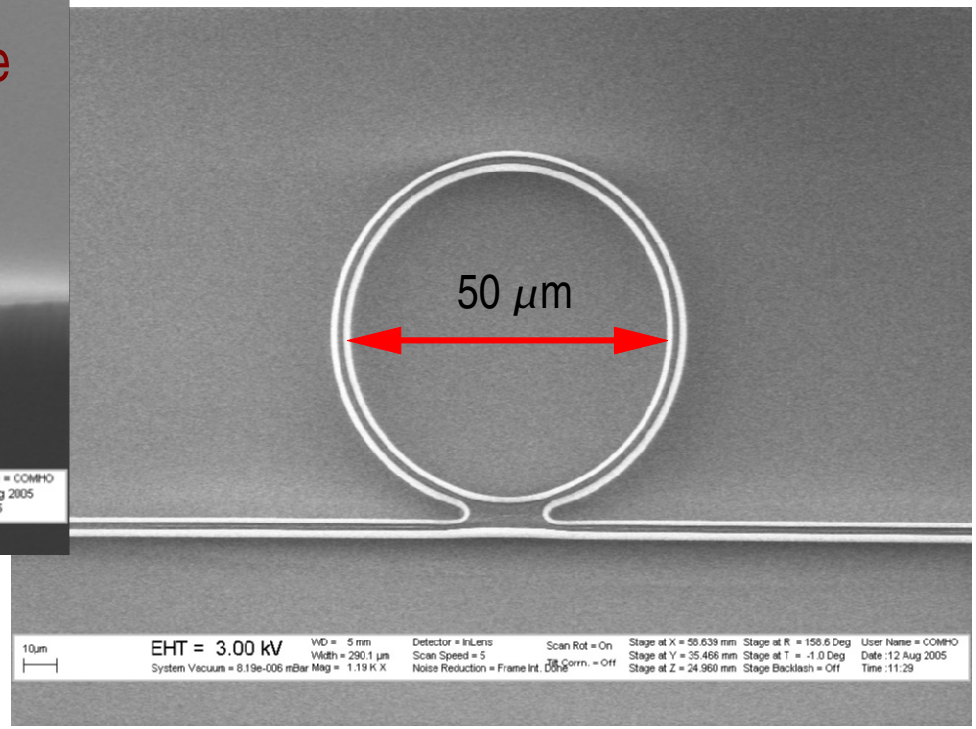
SEM Pictures of Waveguide and Resonators





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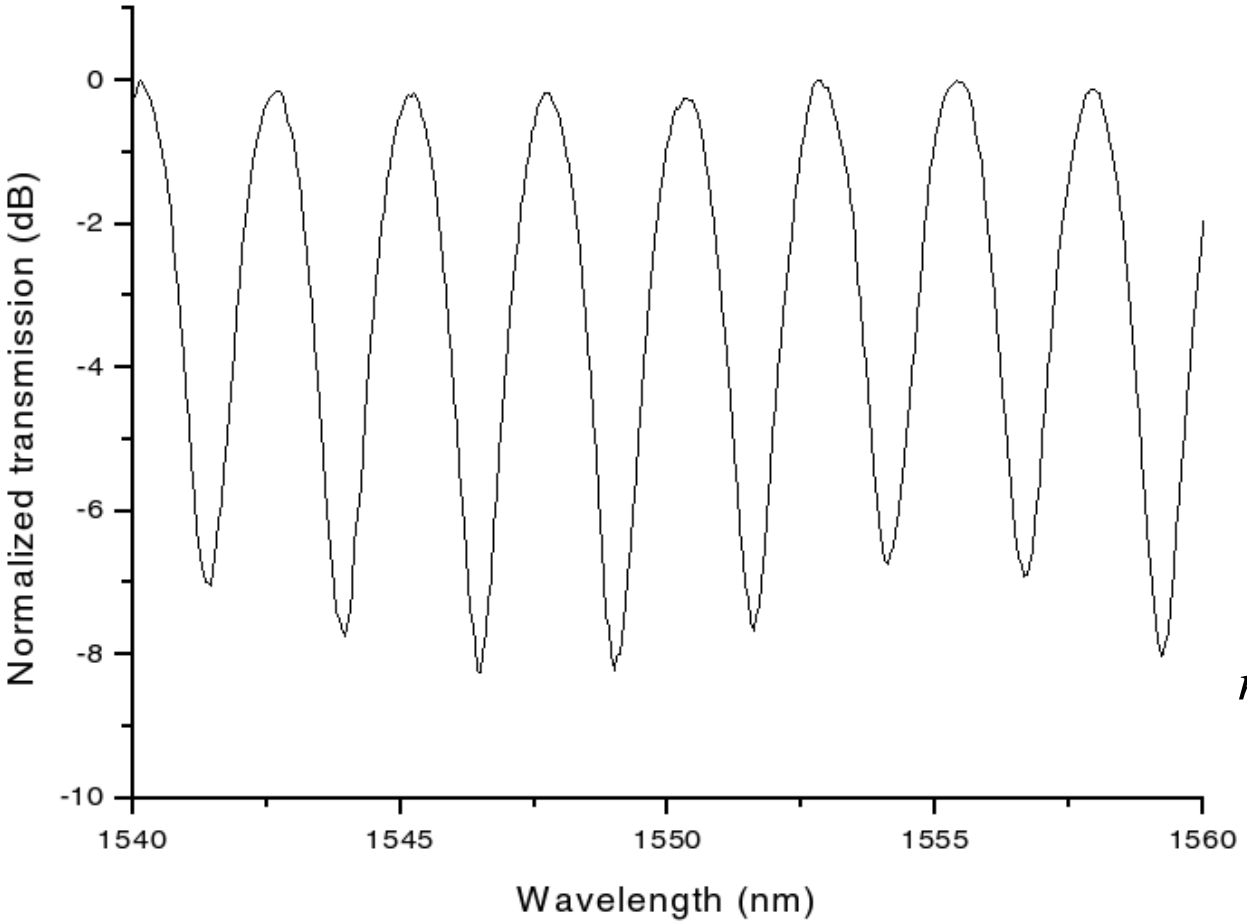
Spectra (slide 1)

100 um radius ring resonator



$$FSR = \frac{\lambda^2}{n_g 2\pi R} = 2.64\,nm$$

$$n_g = \frac{(1.55\,\mu m)^2}{2\pi(100\,\mu m)(2.64\,nm)} = 1.45$$

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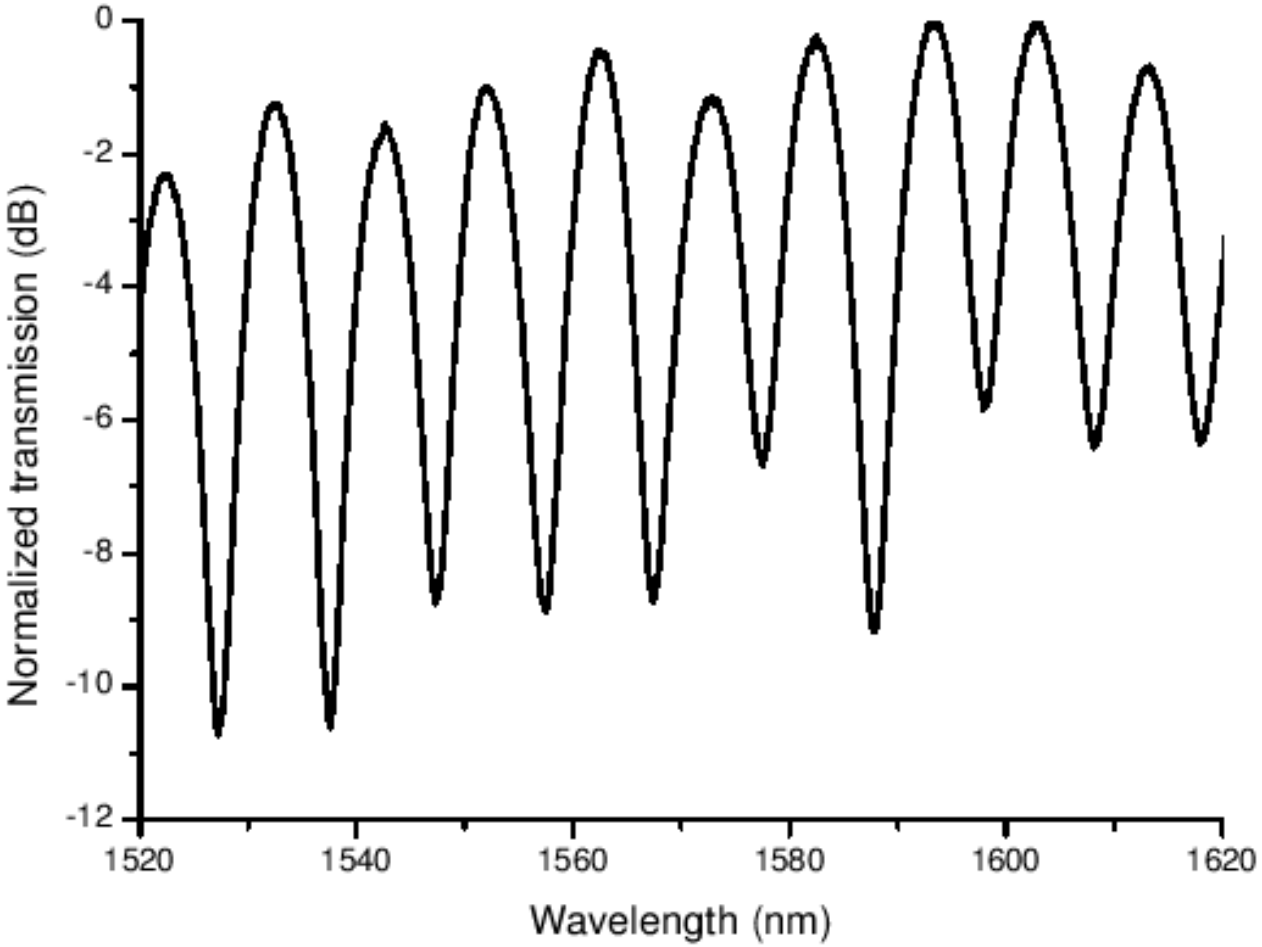
Spectra (slide 2)

25 um radius ring resonator



$$FSR = \frac{\lambda^2}{n_g 2\pi R} = 10.14\,nm$$

$$n_g = \frac{(1.55\,\mu m)^2}{2\pi(25\,\mu m)(10.14\,nm)} = 1.51$$

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Summary

- Low-index contrast silica-on-silicon is an established planar waveguide technology.
- Ring resonators are attractive compact devices.
- High-index platforms have problems – e.g. geometrically induced birefringence.
- Deep glass etching has the potential to selectively utilize high-index contrast when needed.
- Ring resonators have been demonstrated.