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PHOTONICS RESEARCH LABORATORY

Nanoporous Silicon Waveguides for Biosensing Applications

Anqi Fu

Shu-Zee Alencious Lo[1]

Paveen Apiratikul[1]

Andrea Giovannozzi [2,3]

Prof. Thomas E. Murphy[1]

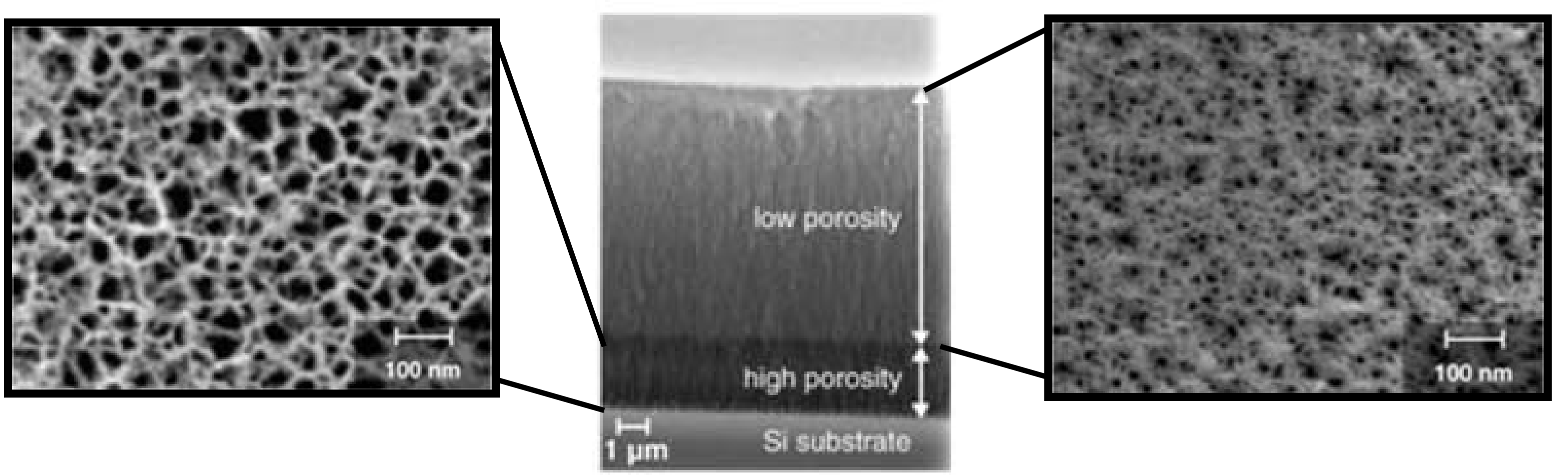
[1] University of Maryland, College Park
[2] University of Torino, Italy
[3] National Institute of Standards and Technology

Overview

- Background
- Motivation for research
- Fabrication process
- Preliminary results
  - Infrared imaging of modes
  - Power transmission and loss
- Summary of accomplishments

Background

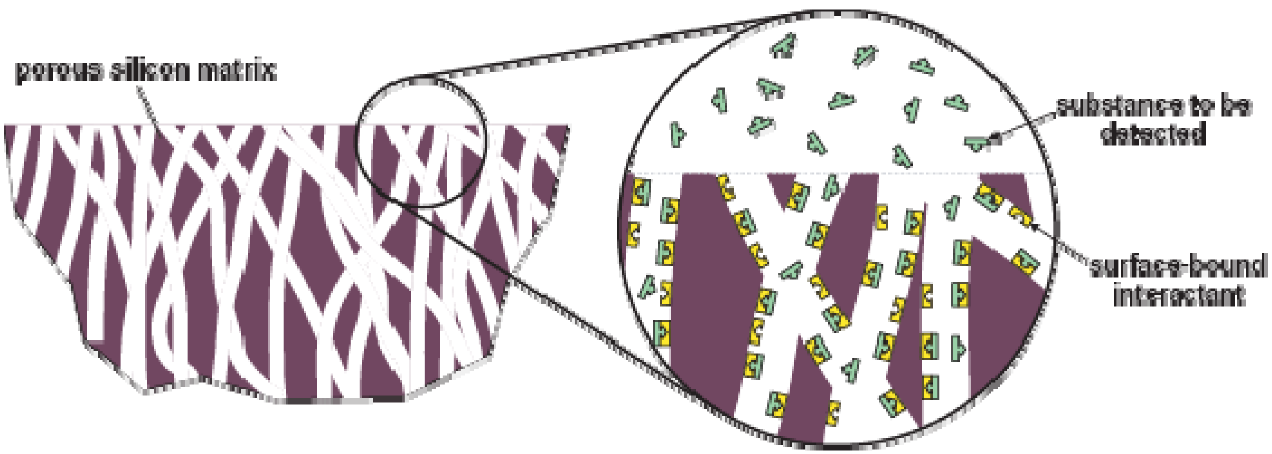
- Electrochemical etching of silicon
  - Nanoscale pore size << wavelength of light
  - Multi-layer structure formed by varying applied current density



- Advantages of Material
  - Simple fabrication, tunable refractive index ($n_{air} < n_{eff} < n_{Si}$)
  - High surface area to volume ratio → better sensitivity

Motivation

- Label-free biodetection
  - Fast, inexpensive, portable applications
  - Optical property changes in the presence of biomolecules



- **Our Goal:** Mach-Zehnder interferometer
  - Conjugate interactants to surface
  - Measure peak shifts and alterations in material's refractive index

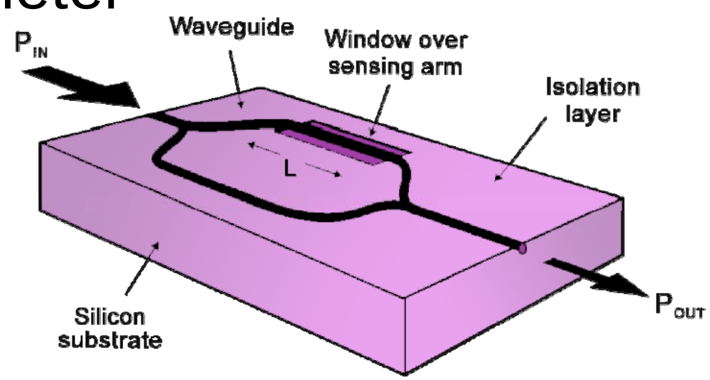


Image credit: Journal of Lightwave Technology

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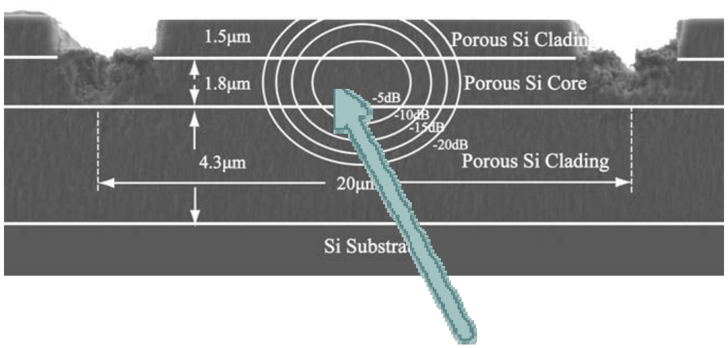
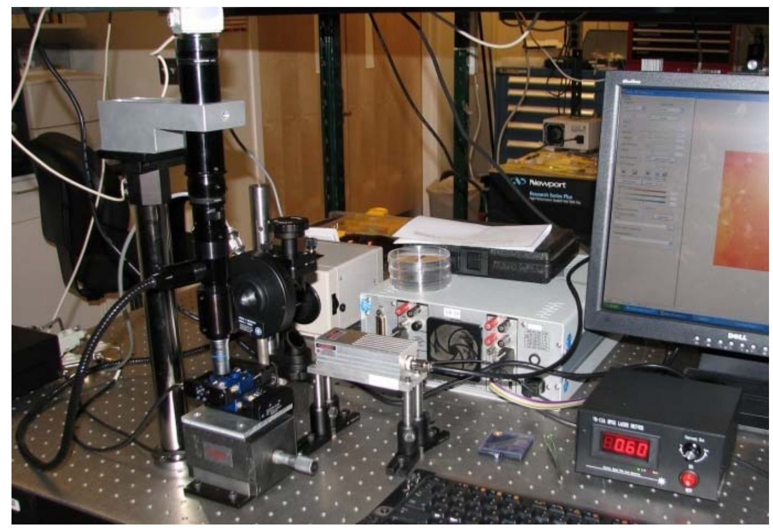
Fabrication

- Laser local oxidation to define guided path
  - Motorized XY stage controls oxidation of wells
  - Real-time imaging of wafer during writing



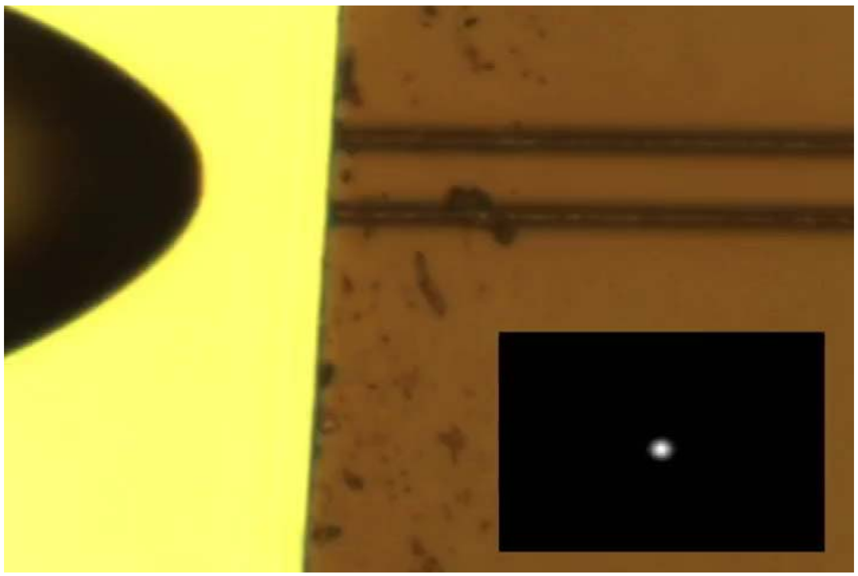
Light confined in core
between etched wells



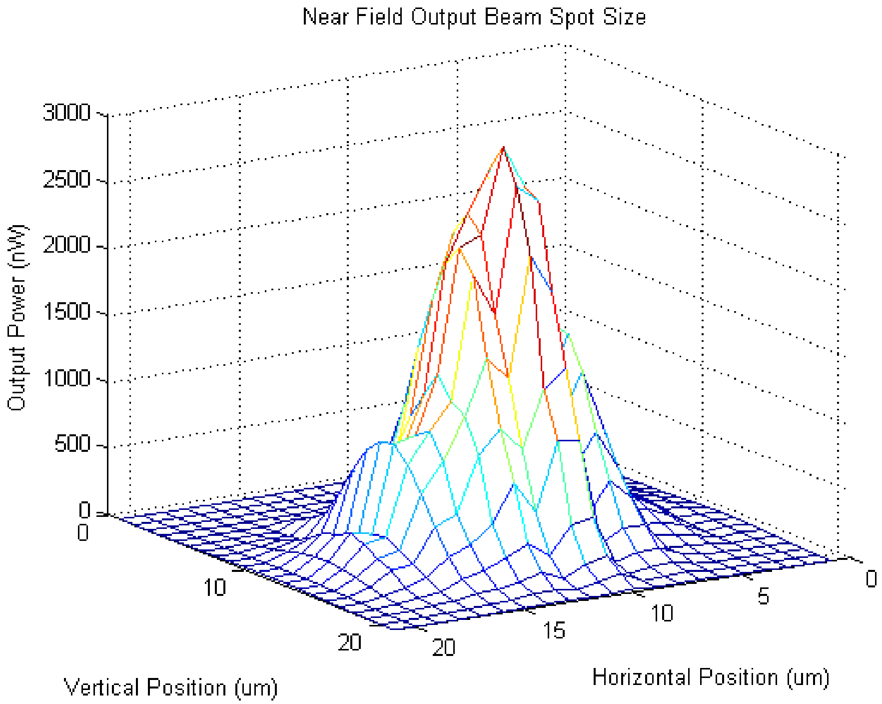
- Power transmission measurements
- Infrared photography of output beam

Results

- Linear waveguide 5 mm long, optimal width 20 µm
  - P_{in} = 1.4 mW, P_{out} = 8 µW → Total insertion loss = -22 dB
- Single mode beam at output

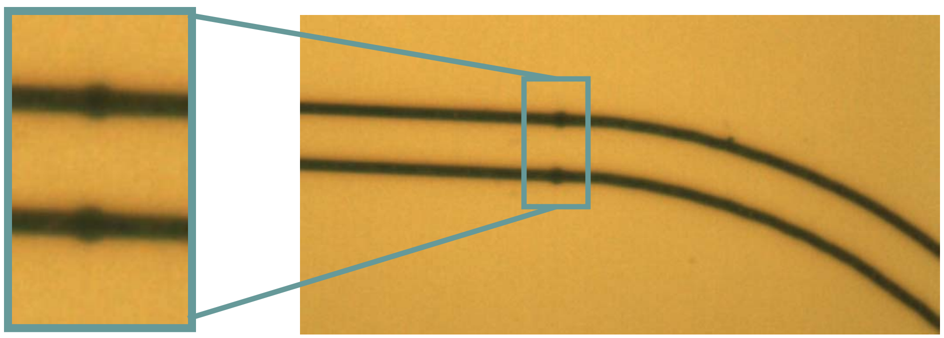


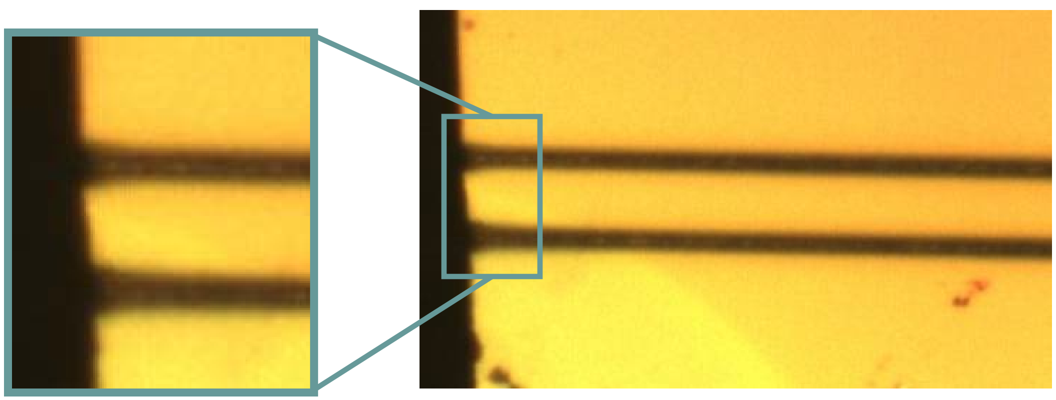
Light at output changes as input fiber moves across waveguide

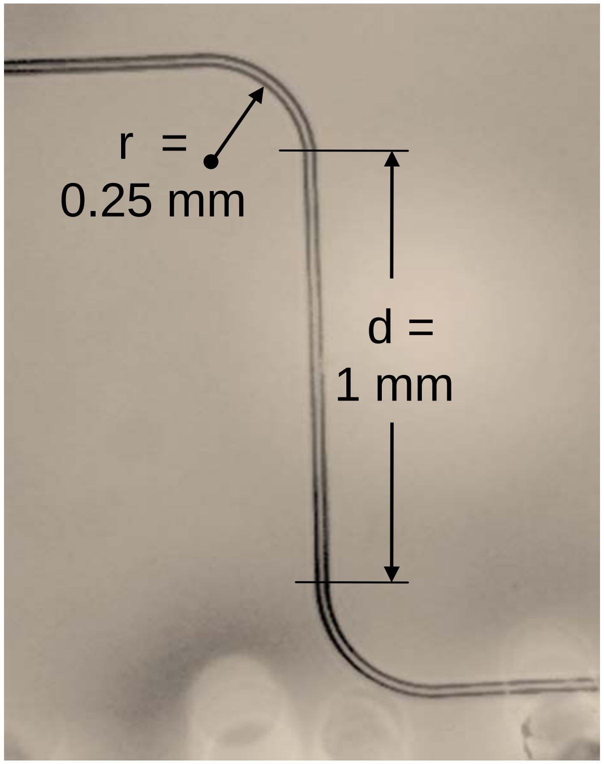


Results

- 90° bend waveguide exhibits high loss
  - Curved path may contribute to light leakage
  - Flaws in oxide at edges and bends
- Next step: Vary radii to determine loss dependency







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Summary

- Designed, built and programmed scanning laser system for defining guided paths
- Successfully fabricated single-mode porous Si waveguides and measured insertion loss

- Future research
  - Determine optimal parameters to reduce bending and scattering loss
  - Fabricate Mach-Zehnder interferometer

Any Questions?