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The Loss Mechanism of Nanoporous Silicon Optical Waveguide for Biochemical Sensors

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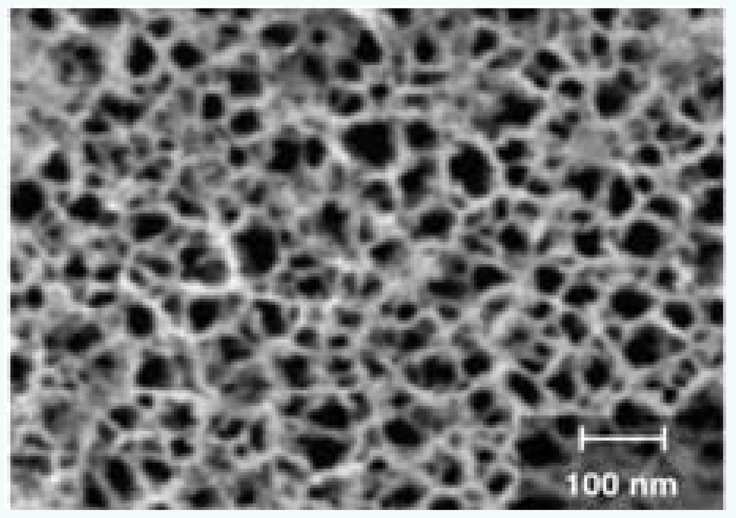
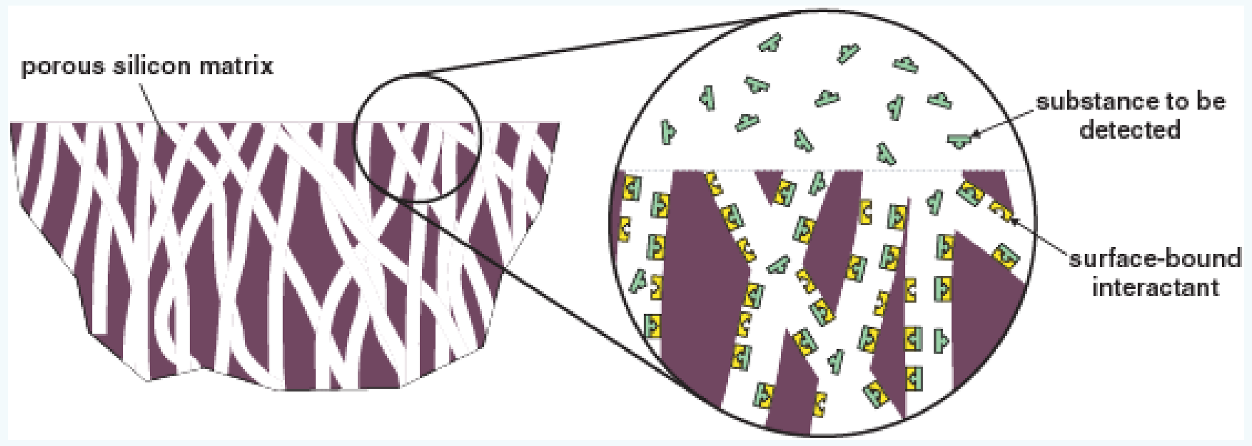
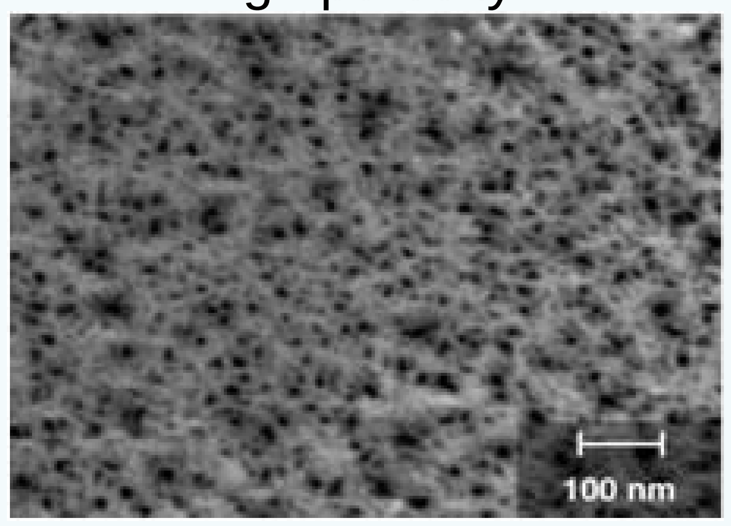
Introduction

- Nanoporous Silicon
  - Large surface area
  - Large range of porosities, refractive indices
- Nanoporous Silicon Optical Waveguide
  - Vertical confinement: multilayer structure
  - Horizontal confinement: laser local oxidation
- Optical biochemical sensors



High porosity

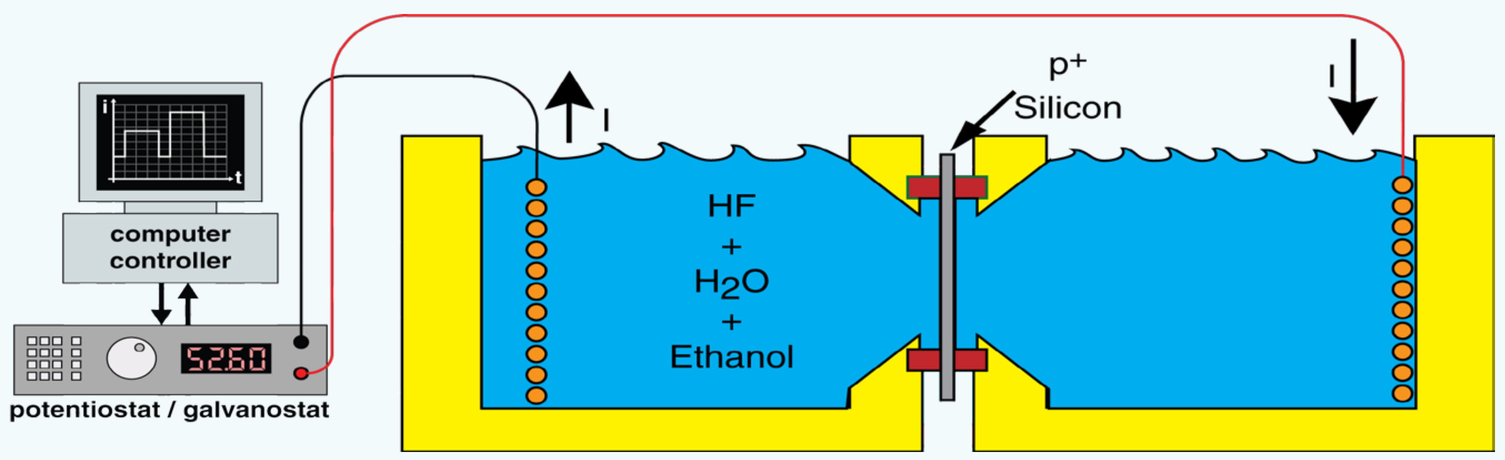


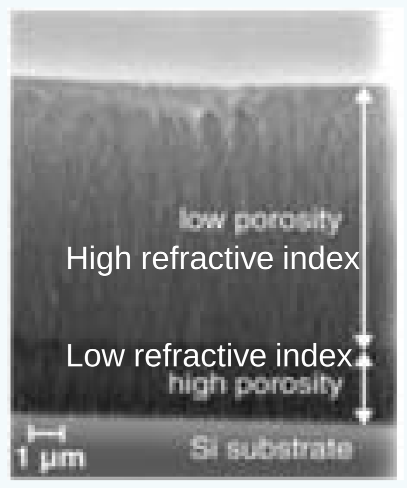


Low porosity

Fabrication

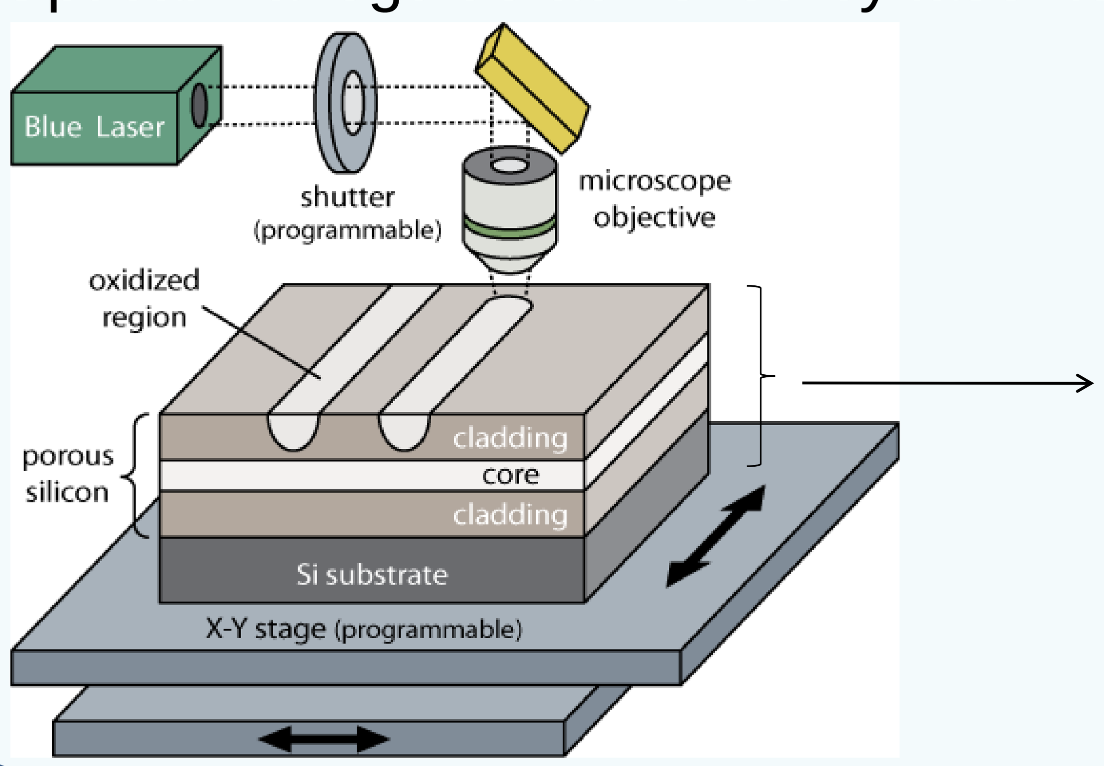
- Electrochemical anodization

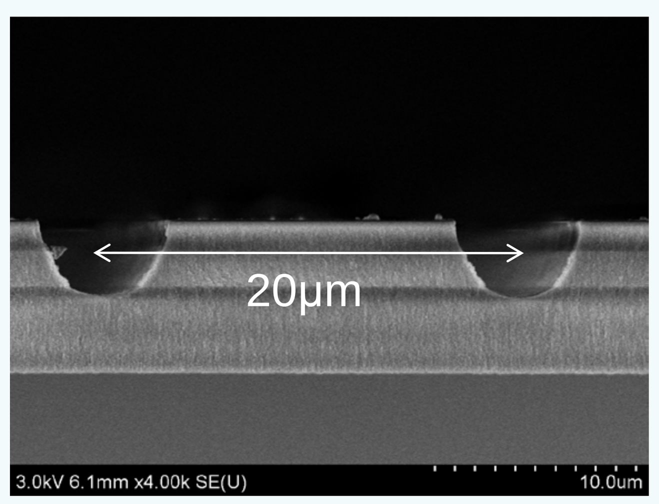




- p++ silicon wafer
- Applying different current densities ⟶ different porosities
- High porosity ⟶ low refractive index
- Low porosity ⟶ high refractive index

- Laser writing system
  - Optical waveguide achieved by laser local oxidation

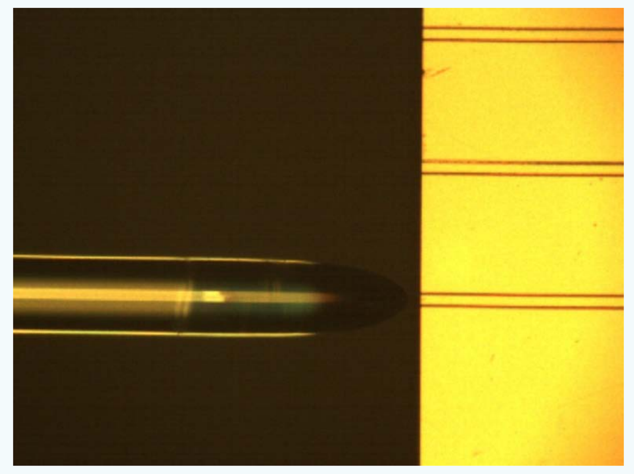


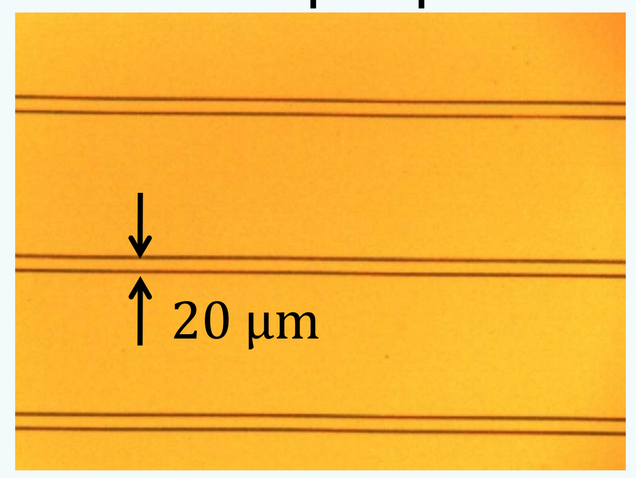


SEM cross section picture

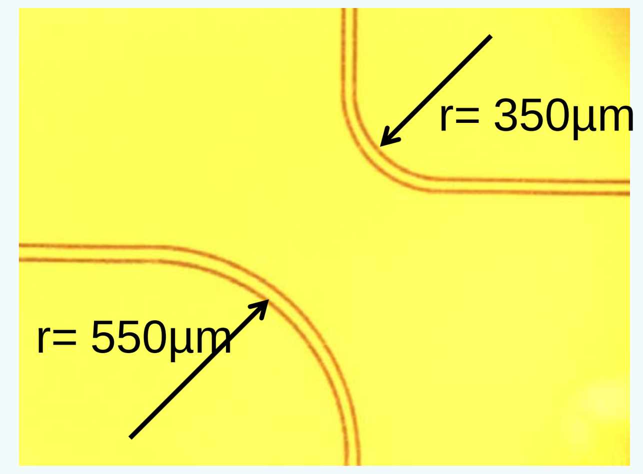
Experimental Arrangement

- Fiber coupling optical waveguide measurement
  - 1550nm wavelength with 0.879mW input power



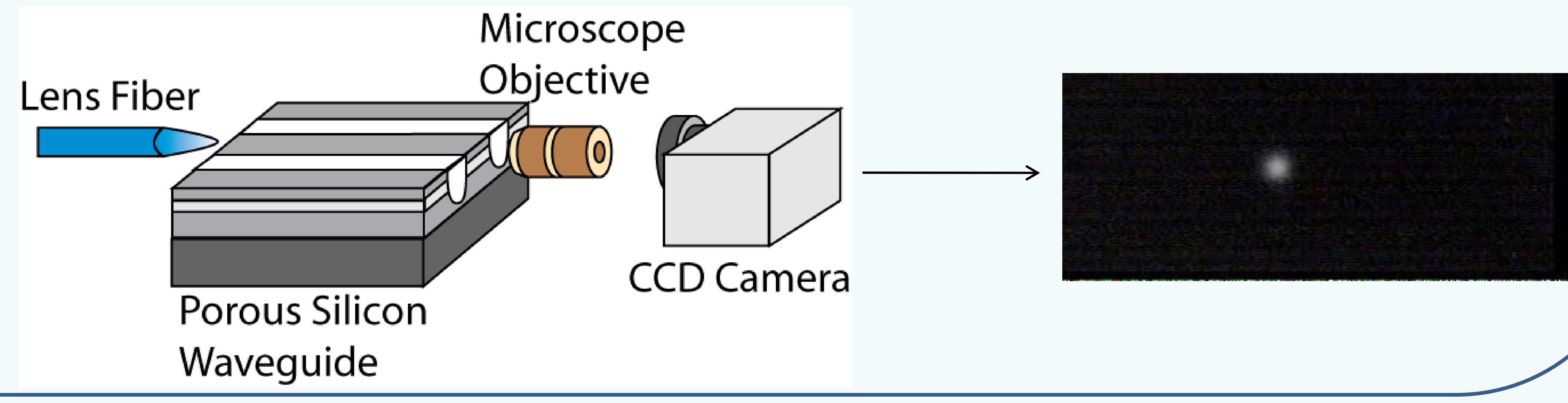


Straight waveguide



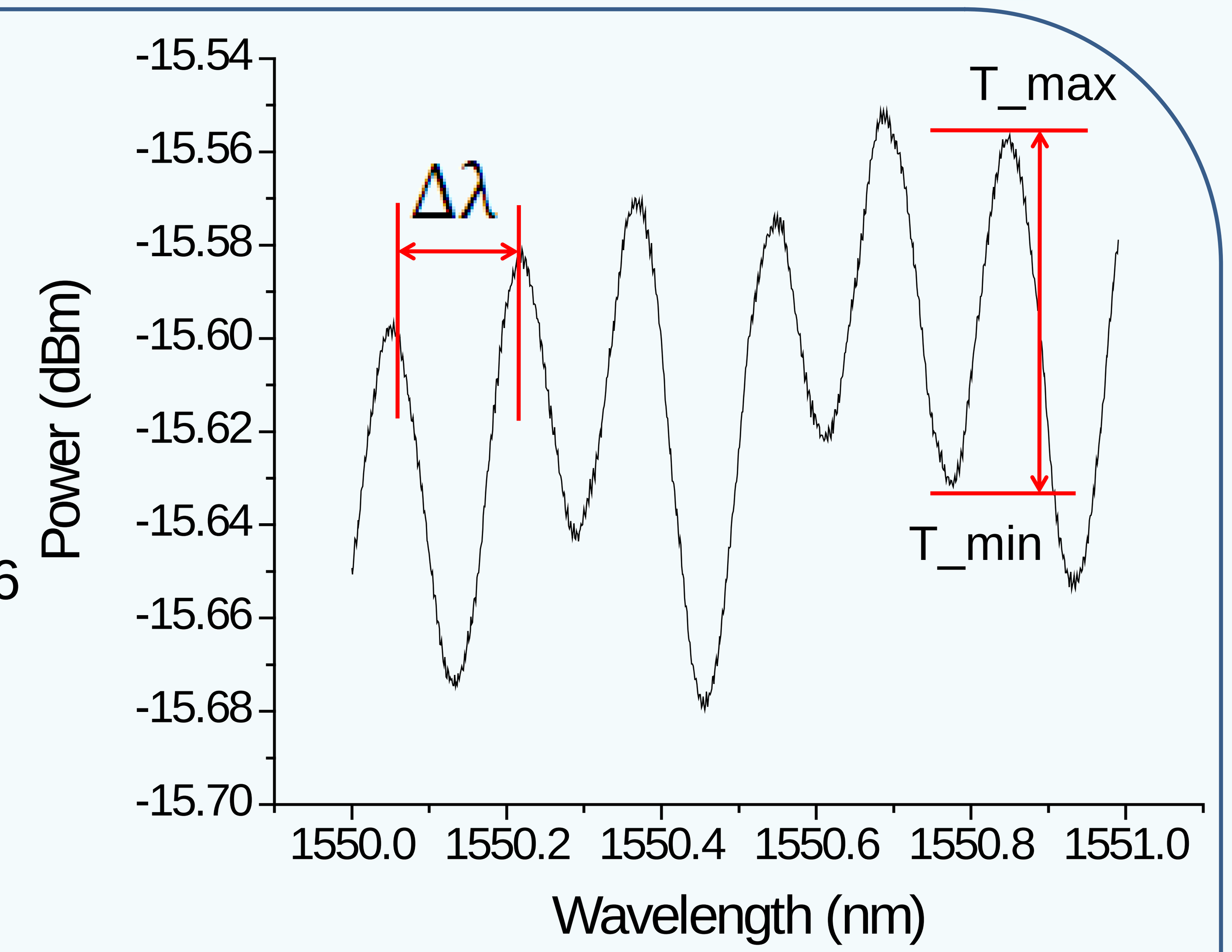
Bent waveguide

- Single mode test



Result

- Output power = 0.112mW
- Total loss = -8.948dB
- Fabry Pérot interferometry
  - Interference fringe
  - Effective refractive index = 1.6
  - Propagation loss = -13dB/cm
  - Coupling loss= -2.63dB



Conclusion

- Propagation loss is the main loss.
- Loss analysis of porous silicon waveguide based on Fabry Pérot interferometry has been achieved.
- Optimized parameters to obtain low loss nanoporous silicon optical waveguide which can be used as biochemical sensors.
- Mach-Zehnder and other on-chip interference devices can be achieved in the future using the optimized parameters.

Acknowledgment

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