On-chip gas detection in silicon optical microcavities

1. A chip-scale photonic system for the room temperature detection of **gas composition** and **pressure** using a slotted silicon microring resonator.

2. The shift of resonance wavelength due to the presence and pressure of acetylene gas and resolve differences in the refractive index as small as 10-4 in the near-IR, is used for sensing.

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Measurement principles

1. By measuring changes in the resonant wavelength of the microring ($\Delta\lambda$), we can detect small changes in refractive index of the gas (Δn_{gass})

Resonant wavelength shift due to refractive index changes

$$\Delta\lambda = \lambda_0 \left(\Gamma / n_{eff}\right) \Delta n_{gass}$$

$$\Gamma \equiv \frac{n_{gas} \int_{gas} |\mathbf{E}|^2 \, dA}{Z_0 \int_{\infty} \left(\mathbf{E} \times \mathbf{H}^*\right) \cdot \hat{\mathbf{z}} \, dA},$$

Pressure dependence Refractive index

$$\Delta n = \frac{K_{GD}}{RT} \Delta P$$

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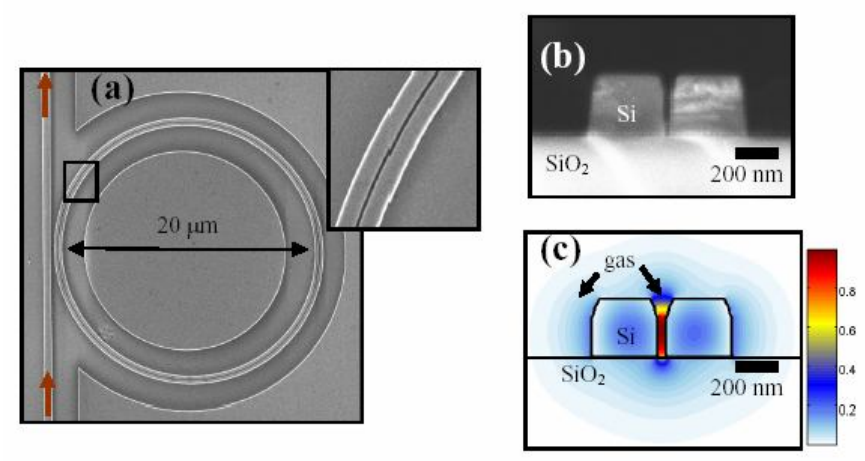
SEM image of a silicon slotted microring resonator



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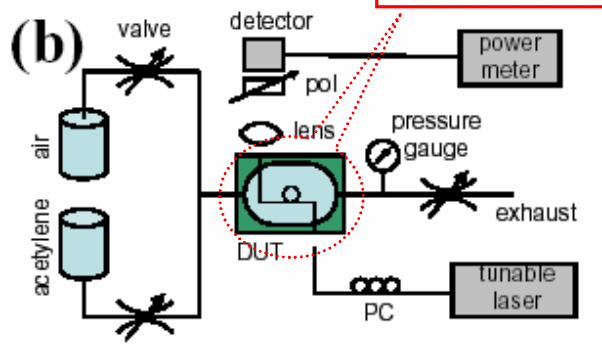
Measurement setup



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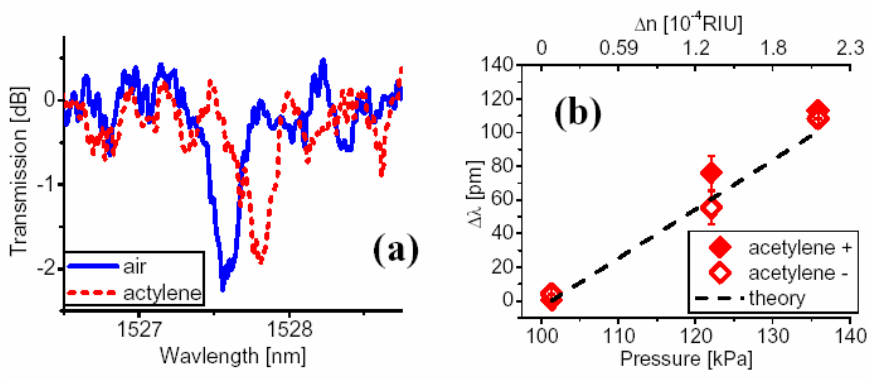
(a) Transmission spectra for the microring resonator in the presence of air (solid) and acetylene gas (dotted) at room temperature and atmospheric pressure. (b) Change in resonant wavelength as a function of gas pressure for acetylene.



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