GC-MS to GC-NOMS: A step towards portable analysis

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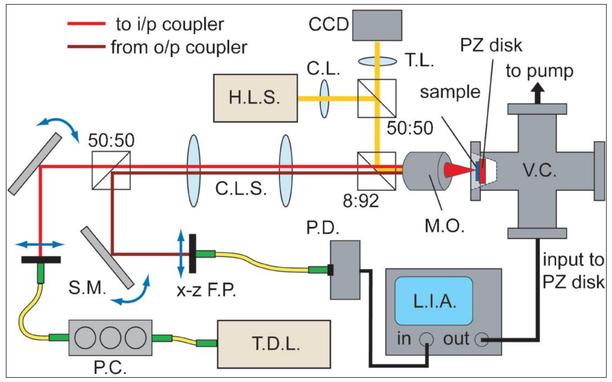
Motivation

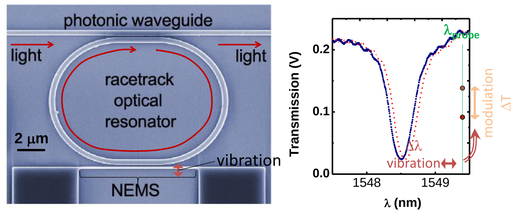
- The objective of this research is to develop portable metabolomic devices for companion diagnostics and personalized medicine.
- The motivation was to identify new sensing mechanism that can potentially replace the Mass spectrometer (MS) from the Gas chromatography (GC) – Mass spectrometer (MS) system to improve its portability

Some target applications:
- ✓biosensing
- ✓gas sensing
- ✓breath analysis
- ✓gas chromatography

Free space confocal optical setup

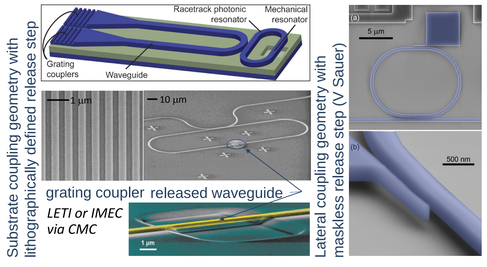


New method for getting light onto chip



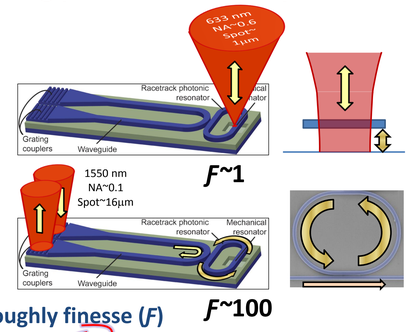
NOMS device fabrication

- SOI platform; Foundry photonic fabrication; NOMS finishing in-house

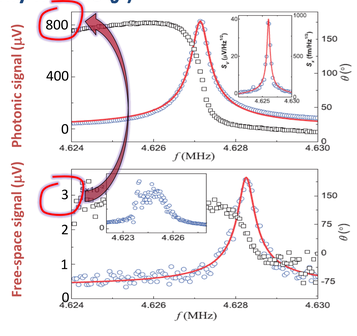


Sauer, Diao, Freeman, Hiebert, Applied Physics Letters 100, 261102 (2012)

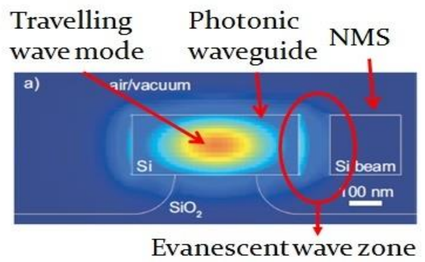
NOMS super-sensitivity
Comparing photonic to free-space transduction

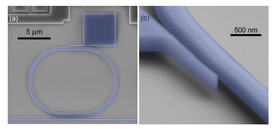


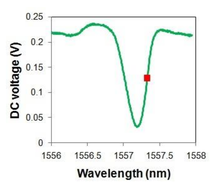
Photonic is roughly finesse (*F*) times better



Optical Racetrack NOMS Devices







NOMS Responsivity: optical transmission equation

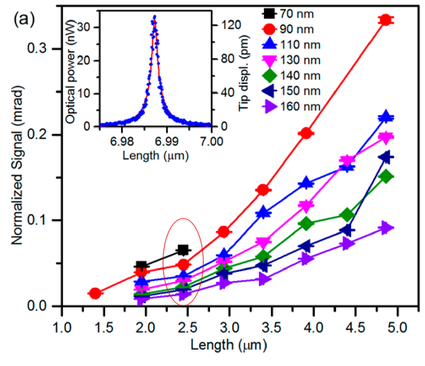
$$\frac{\partial T(\phi)}{\partial z} = \left(\frac{\partial T(\phi)}{\partial \phi}\right)\cdot\left(\frac{\partial \phi}{\partial z}\right)$$

Optical cavity Properties (T_o, F)

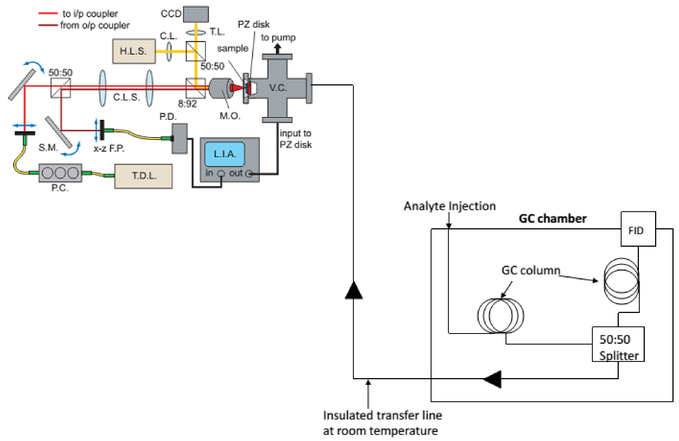
Optomechanical coupling (g_{om}, L_{mech})

$$\left(\frac{\partial T(\phi)}{\partial z}\right)_{max} \approx \left[\frac{3\sqrt{3}}{4}T_0\left(1-10^{-\alpha/10}\right)\mathcal{F}\right]\cdot\left[\left(\frac{g_{om}}{2\pi}\right)\frac{n_{eff}}{c}\cdot\beta\cdot\chi\cdot l_c\right]$$

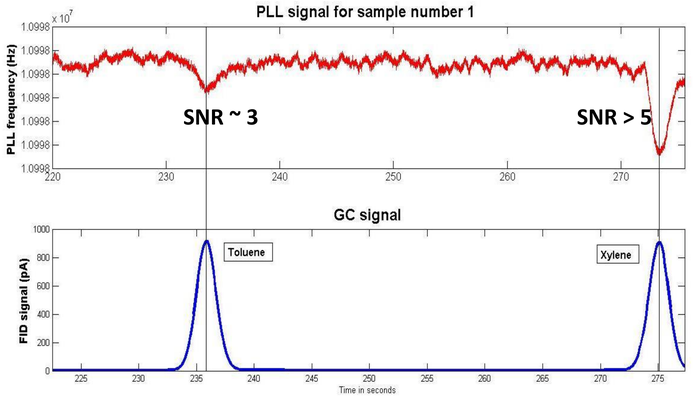
Thermomechanical Noise Signal Normalized By *dT/dϕ*: Gap and Length dependence



First NOMS Sensing of GC Peaks



Response to toluene and xylene



Conclusions

- To the best knowledge of the authors, this is the first demonstration of Nano-optomechanical system (NOMS) integrated with Gas chromatography.
- Initial results of analyte adsorption is encouraging with accurate synchronization of analyte peaks. Clear indication of analyte adsorption is when SNR ratio above 2.5.

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