On-chip infrared spectroscopy with near-field detection

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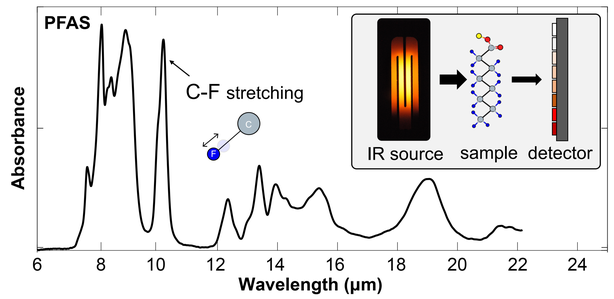
1. Motivation

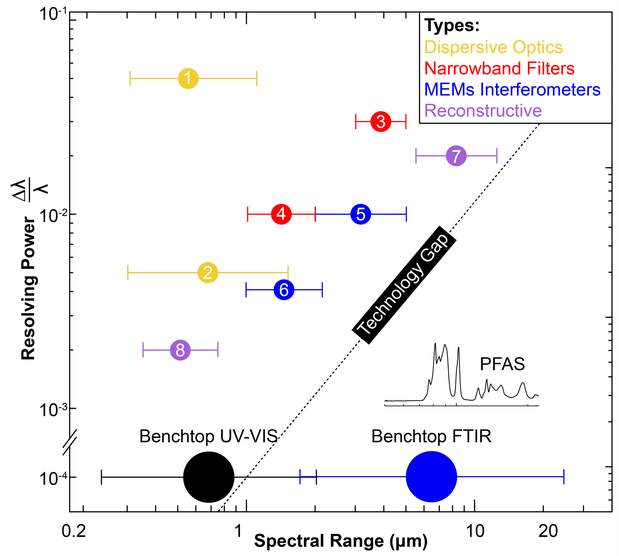
IR spectroscopy captures a vibrational fingerprint



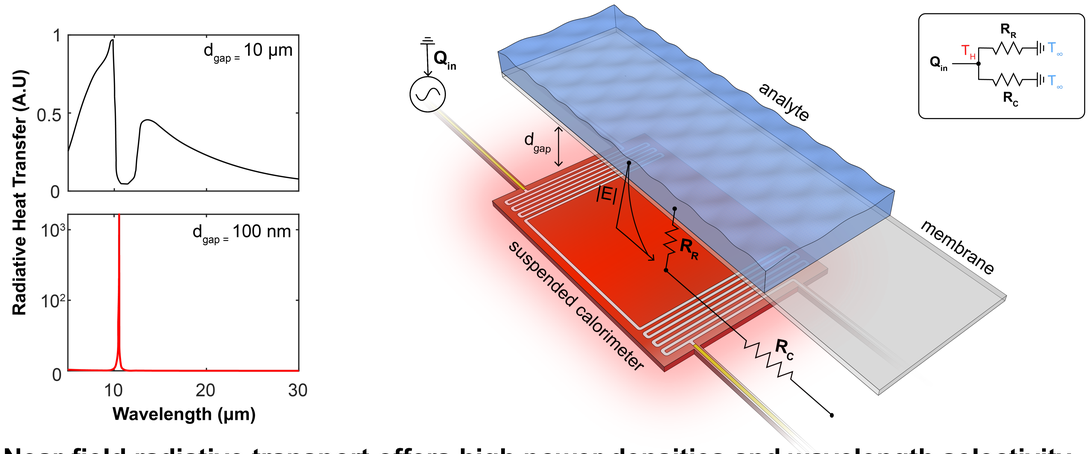
Miniature IR spectrometers can provide cheap and portable analyte detection

2. Technological Gap

Spectral range and resolution of on-chip spectrometers are limited by the lack of available on-chip IR sources



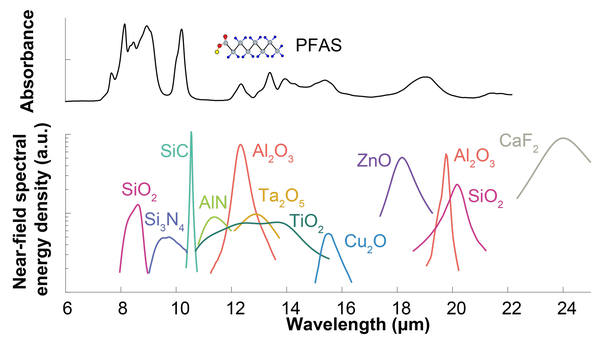
3. Our Solution – Replace traditional IR sources and photodetectors with "all-in-one" near-field calorimeters



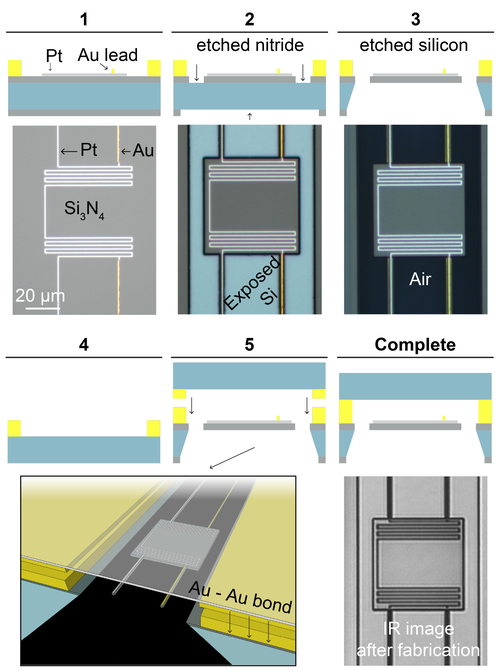
Near-field radiative transport offers high power densities and wavelength selectivity

A new paradigm in IR spectroscopy

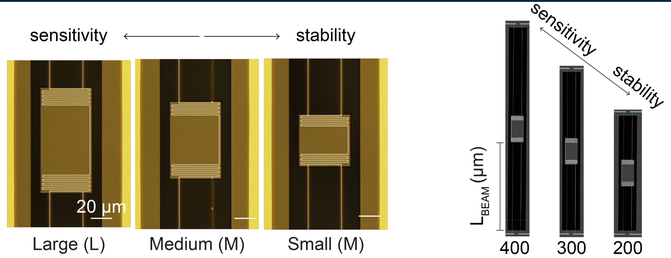
An array of calorimeters made from polar dielectrics and plasmonic materials can be utilized to provide a broad IR spectral range, substantially increasing the spectral range of current on-chip spectrometers



4. Fabrication

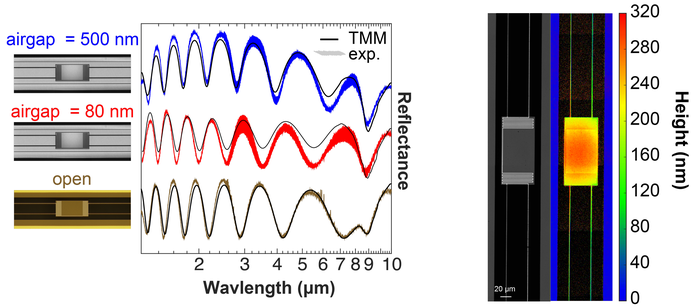


5. Sensitivity vs Stability



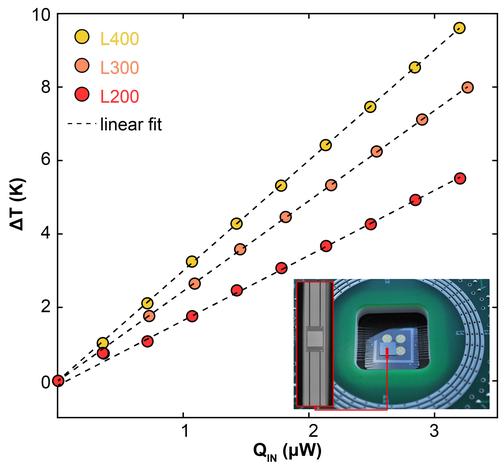
Area and beam length dictate sensitivity and stability

6. Airgap Thickness (d_{gap})



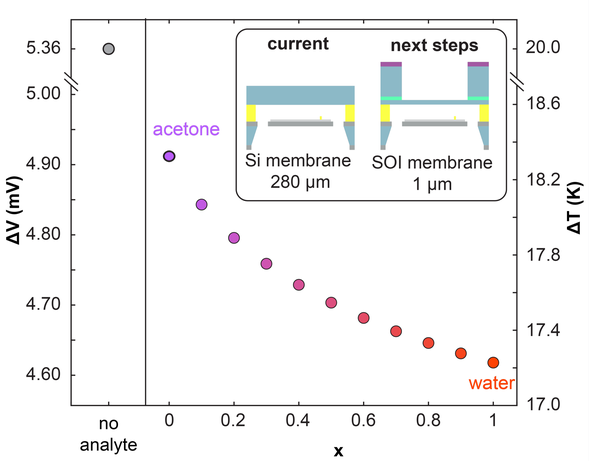
Airgap imprecision is due to calorimeter deflection

7. Preliminary Thermal Testing



Thermal conductance of the beams (without analyte) meets expectations

8. Next Steps



To distinguish between different analytes, a thinner membrane must be implemented

1. D. Sander, J. Mueller, et al. | **Proc. SPIE** | 1996
2. R. Cheng et al. | **Nat. Commun** | 2019
3. Neumann, K. Hiller, et al. | **J. Micro-Nanolith. MEM** | 2008
4. J. Antila et al. | **Proc. SPIE** | 2010
5. T. Sandner, W. Scherf, et al. | **Proc. SPIE** | 2007
6. Y. M. Eltagoury, D. A. Khalil, et al. | Adv. Mater. Technol. | 2019
7. B.J. Craig, V.R. Shrestha, et al. | **Sci. Rep.** | 2019
8. E. Huang, Q. Ma, Z. Liu | **Sci. Rep.** | 2017