

UPISC

UNIVERSITY OF PIITTSBURGH INFRASTRUCTURE SENSING

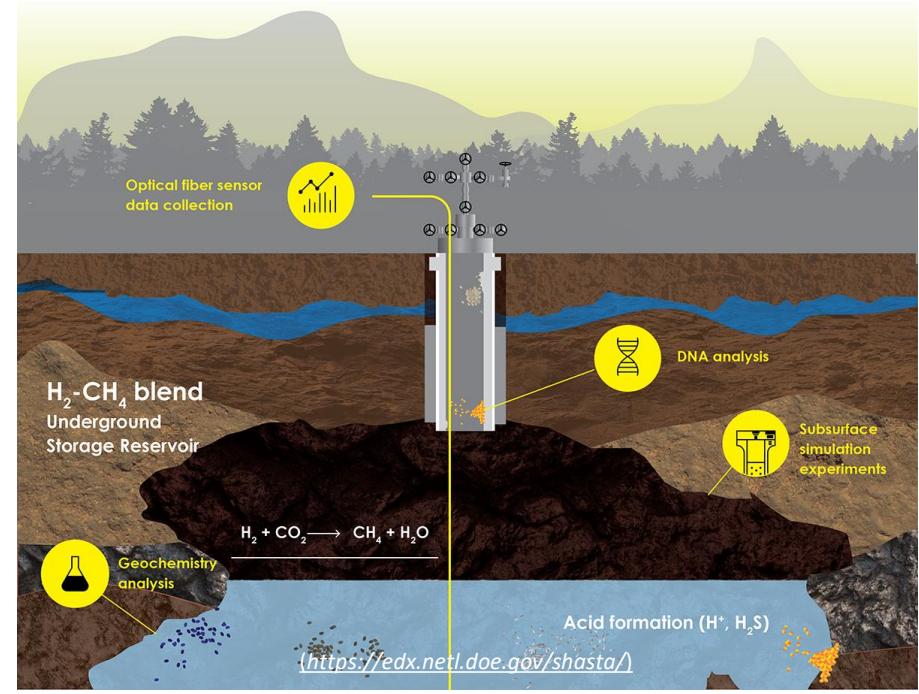
COLLABORATION WORKSHOP

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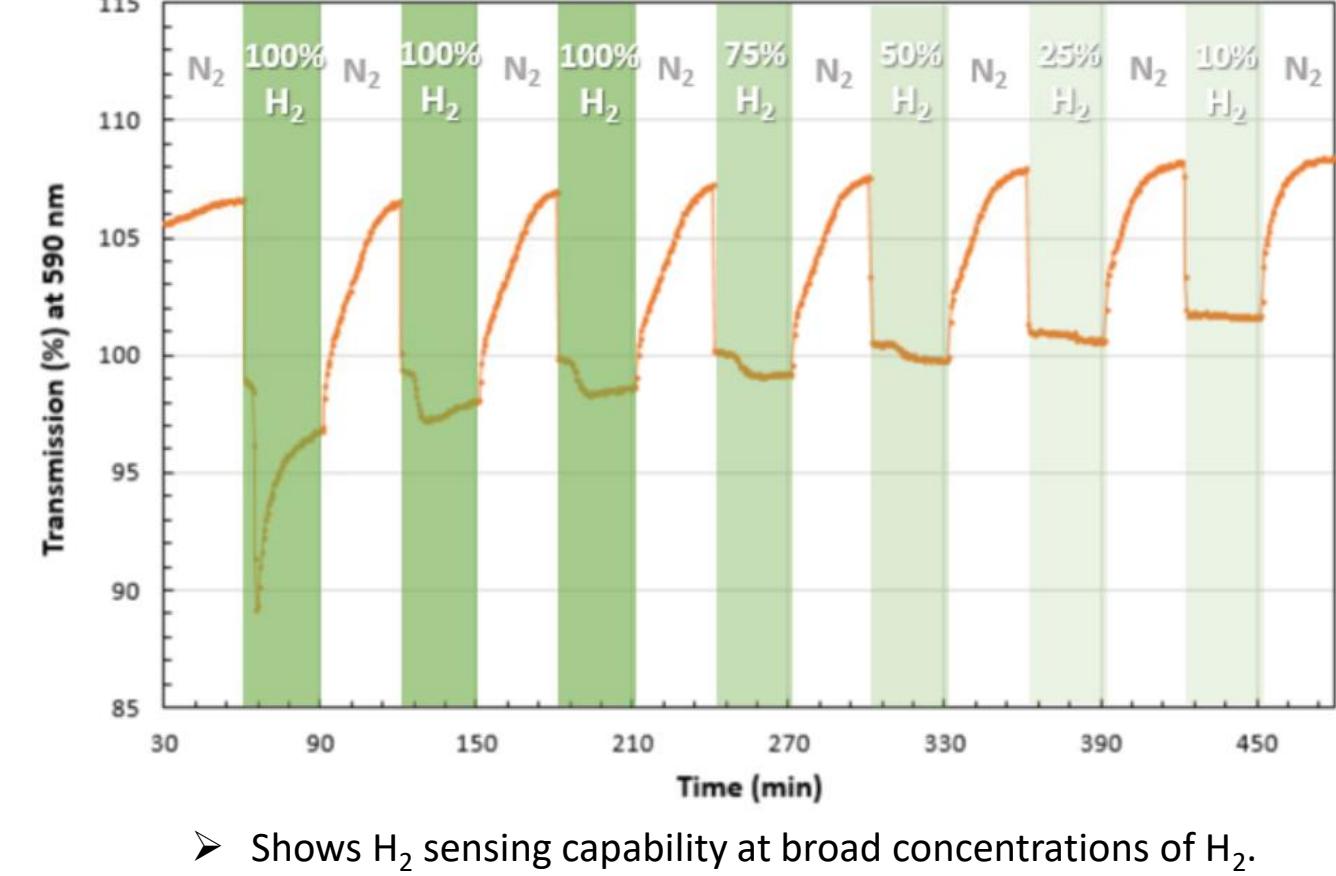
Optical Fiber Hydrogen Sensor

□ H₂ Sensing in Subsurface Storage

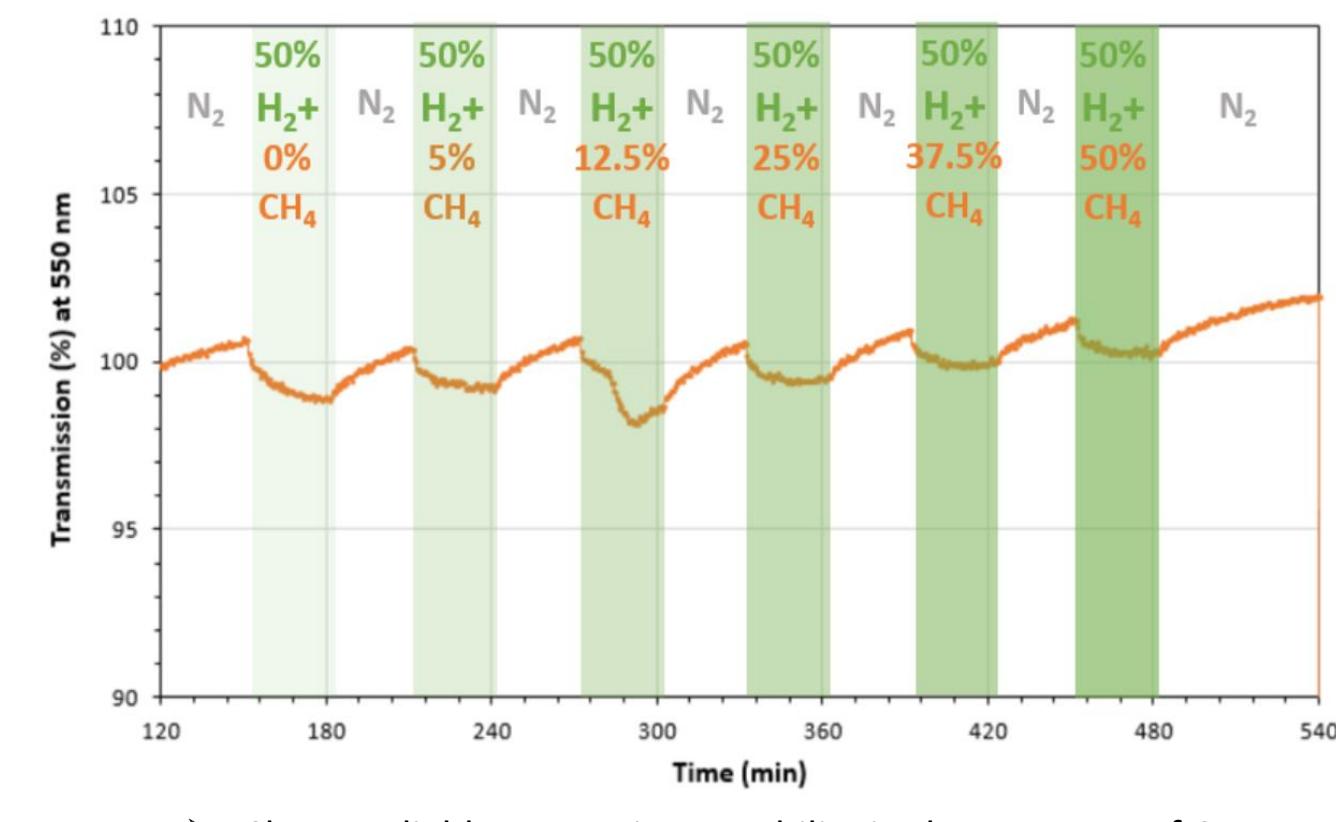


- H₂ subsurface storage to ensure energy reliability and to mitigate the impact of varying production rates.
- Utilize underground natural gas storage fields such as salt caverns, saline aquifer, and depleted oil/gas reservoirs.
- Need to develop H₂ monitoring sensors to manage H₂ leakage risks and assure safe H₂ storage in underground fields.

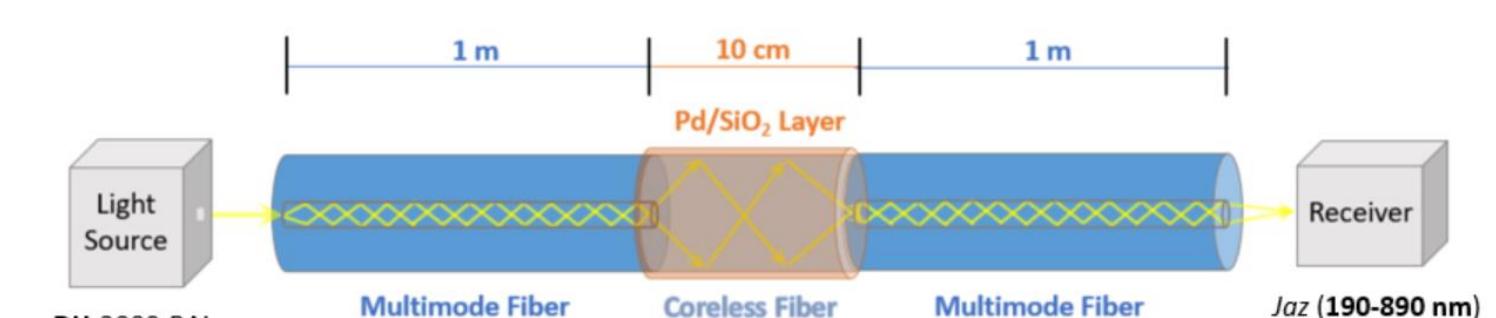
□ Hydrogen sensing at 100% to 10% H₂



□ Hydrogen sensing in the presence of CH₄

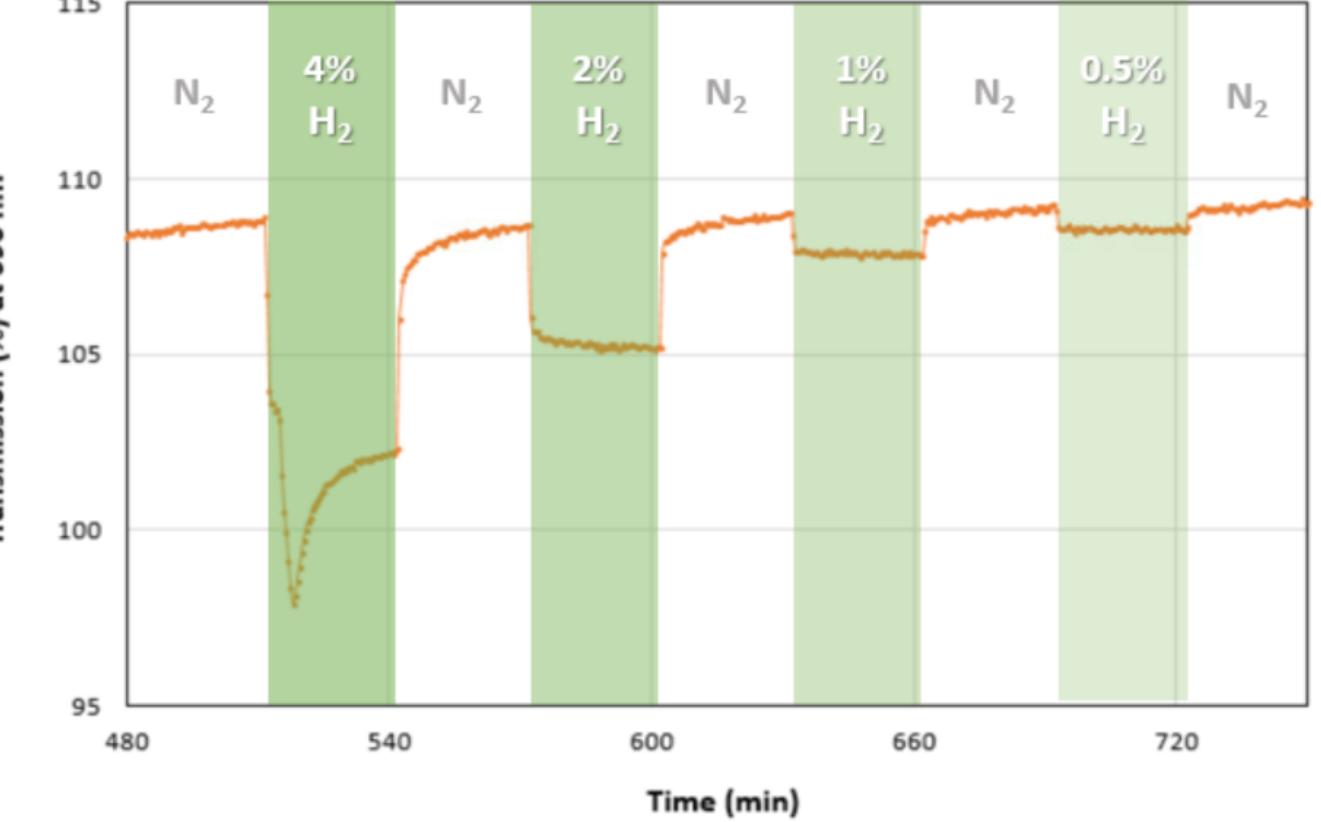


□ Optical Fiber H₂ Sensor Based on Evanescent Field

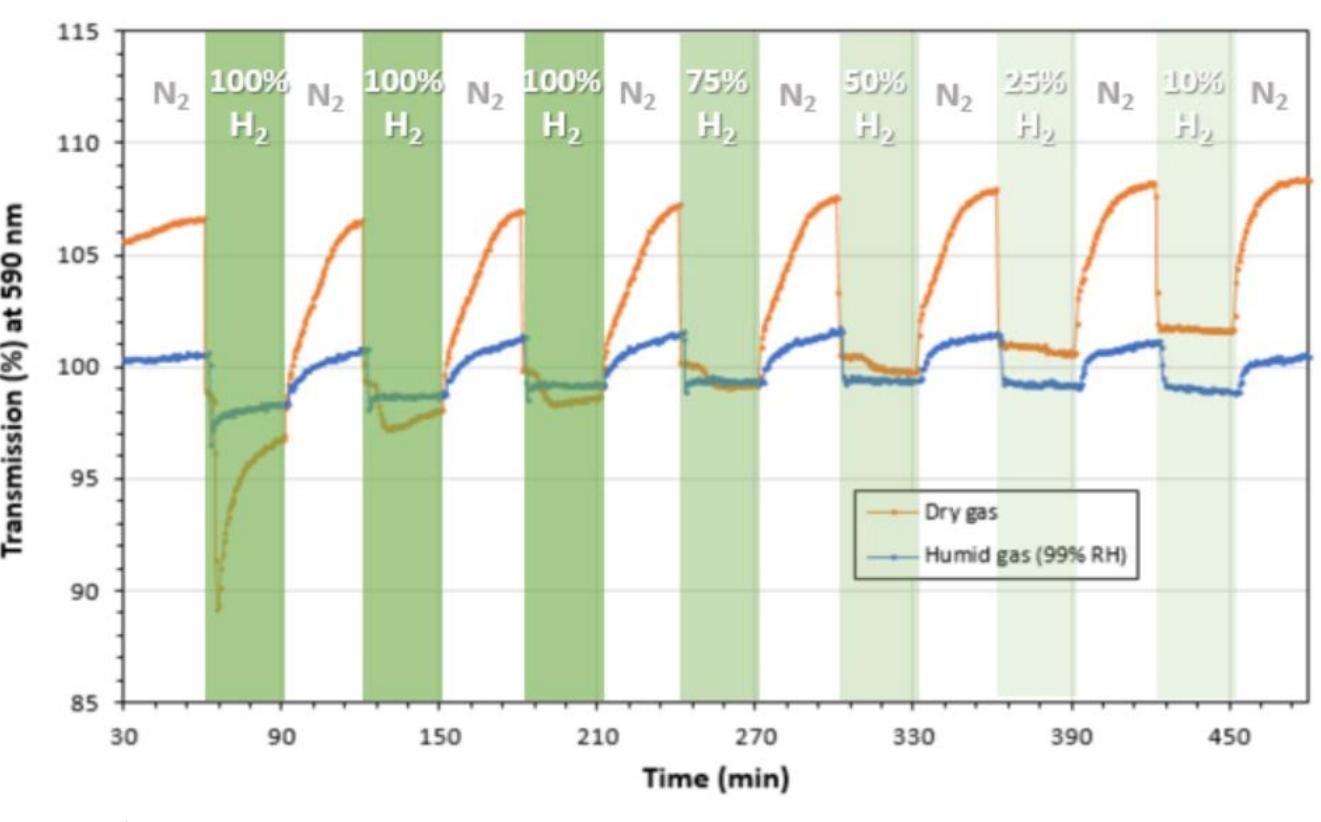


- Optical Fiber: multimode-coreless spliced fiber,
- H₂ Sensing Material: 10 layers of Pd/SiO₂
- Sensing Tests: at room temperature

□ Hydrogen sensing at 4% to 0.5% H₂

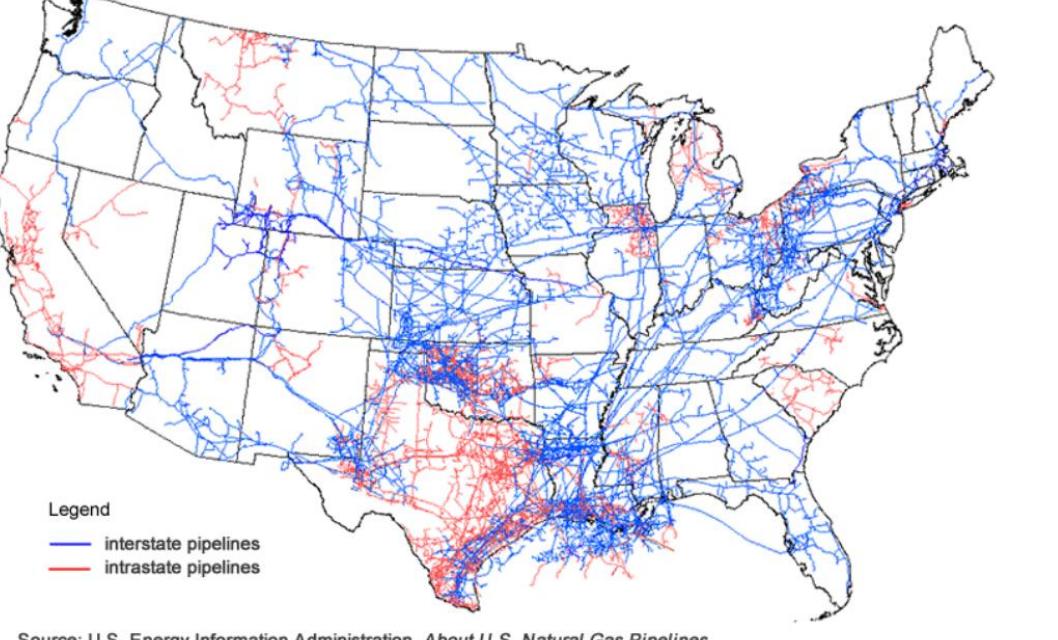


□ Hydrogen sensing under the humid condition

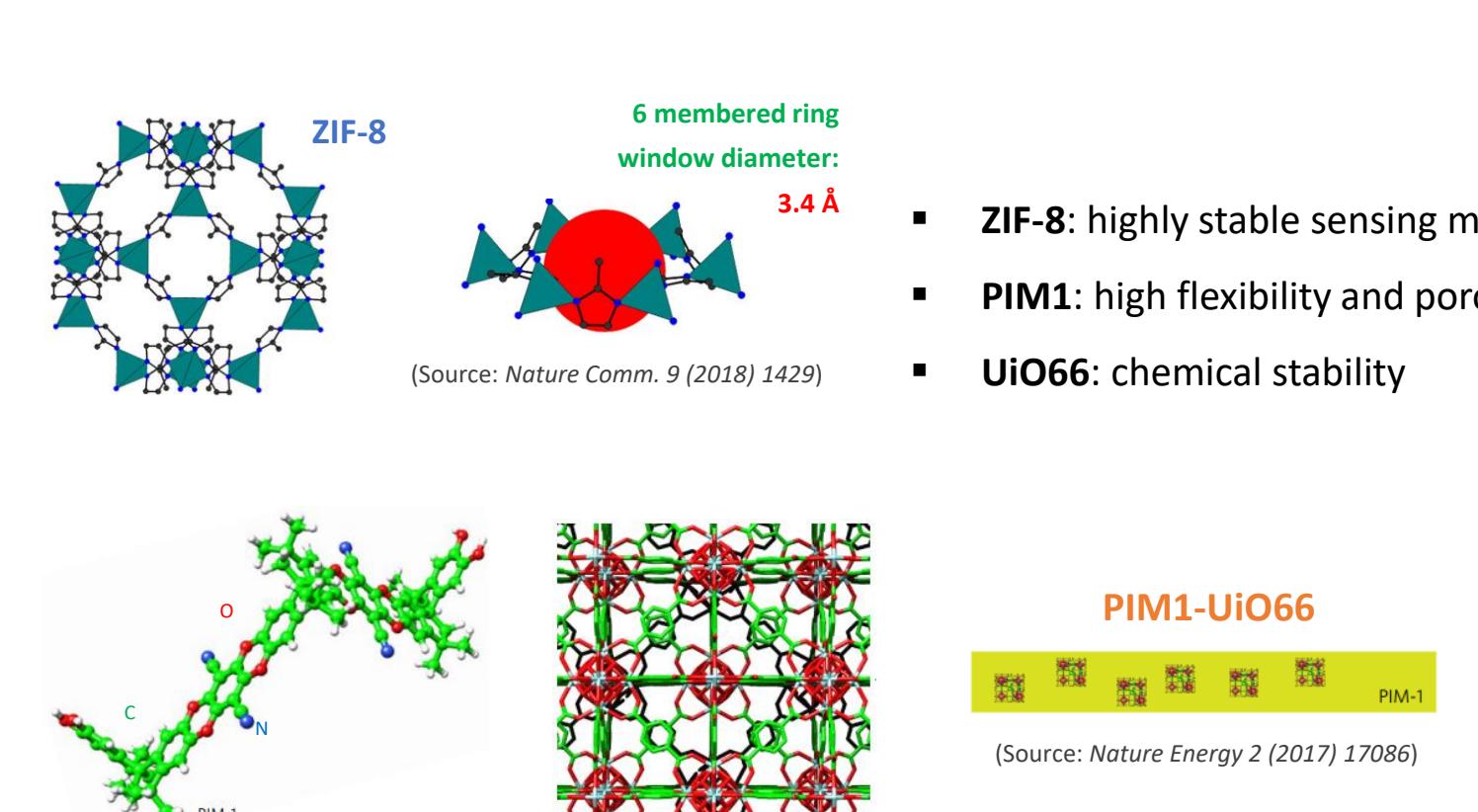


Surface Acoustic Wave Methane Sensor

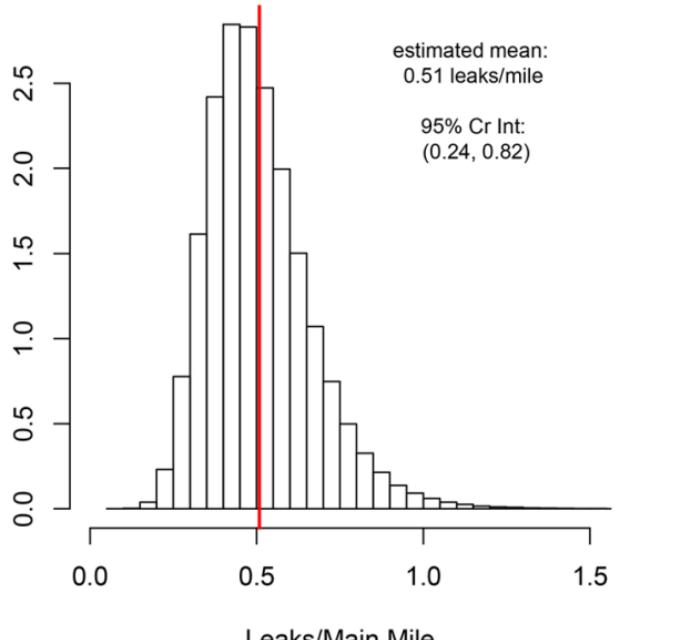
□ Natural Gas Pipelines in the U.S.



□ Multi-elements SAW array sensor (ZIF-8 and PIM1-UlO66)

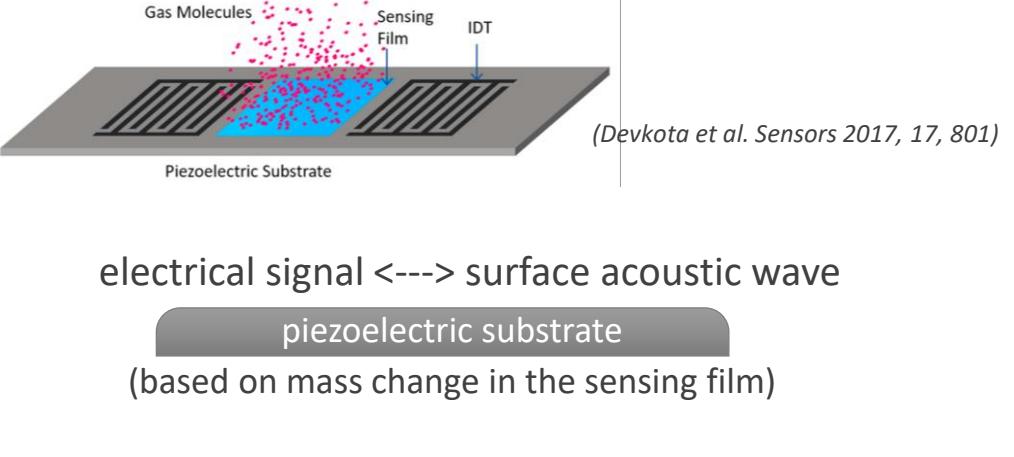


□ Estimated Natural Gas Leaks Per Mile



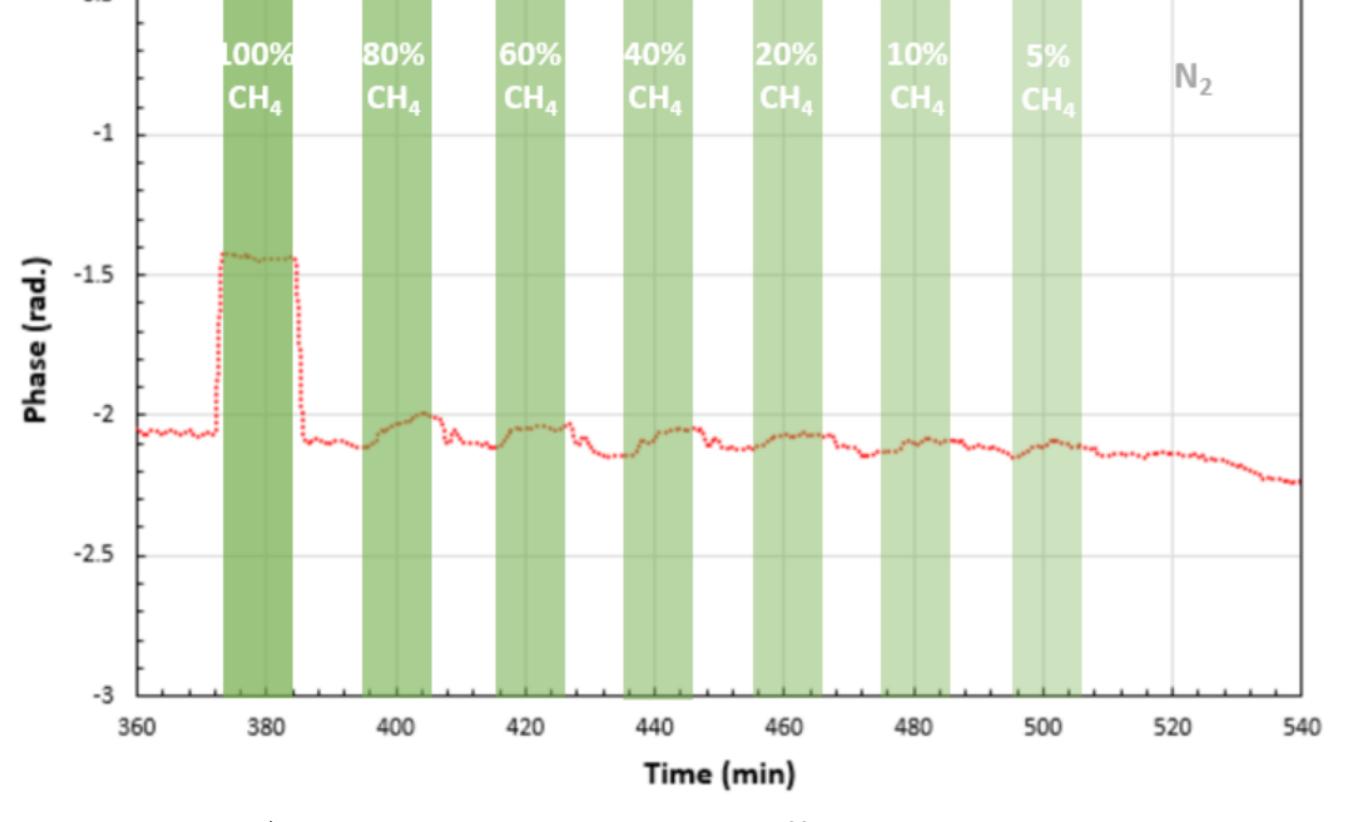
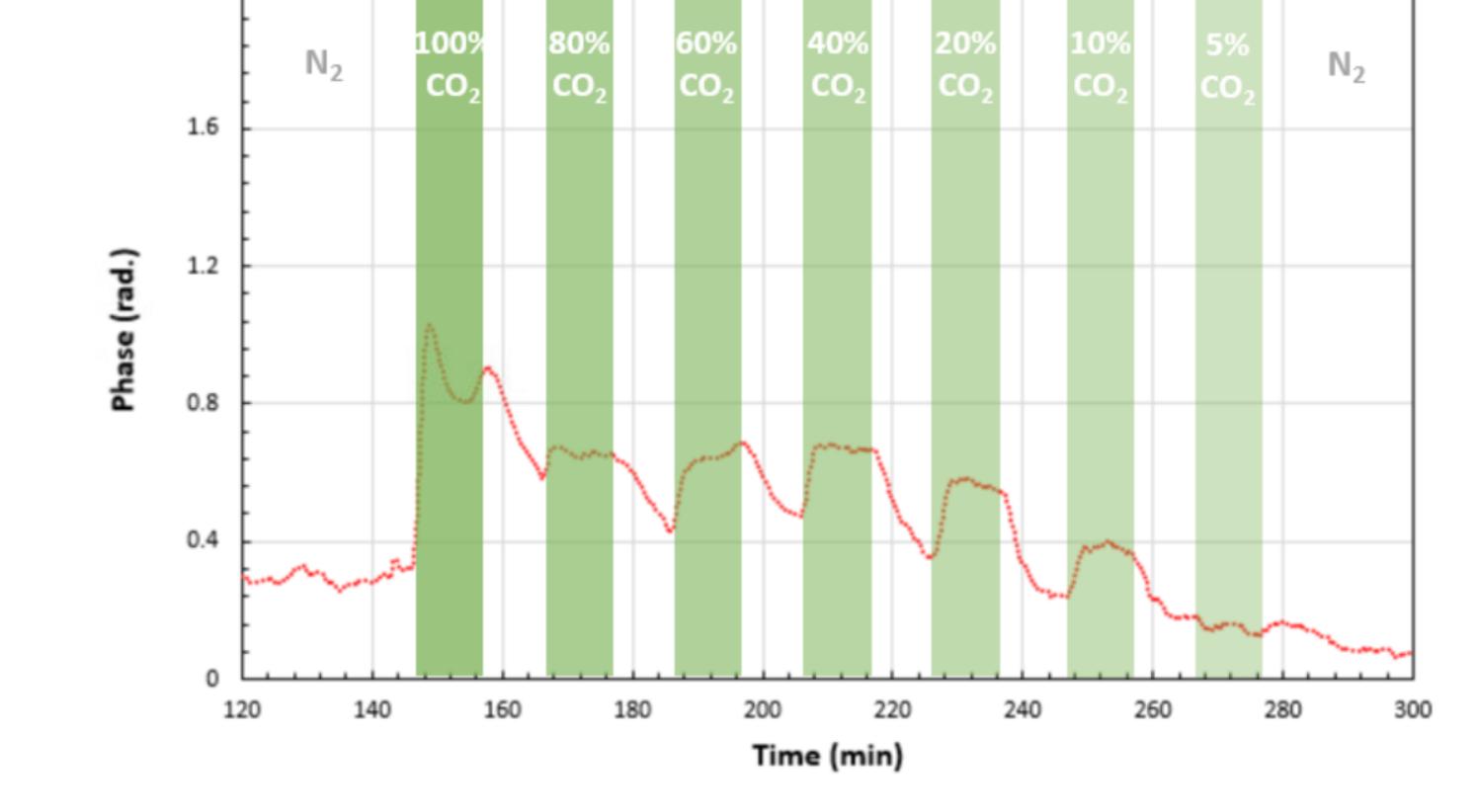
- Humidity: 43% RH
- Test: wireless mode

□ Surface Acoustic Wave (SAW) Sensor:



electrical signal <----> surface acoustic wave piezoelectric substrate (based on mass change in the sensing film)

- High sensitivity, fast response time, reversibility
- Small size, low cost, wired or wireless modes



Conclusions and Next Steps

- Developed the optical fiber H₂ sensor capable of sensing hydrogen at broad range of concentrations from 100% to 0.5% H₂.
- Demonstrated hydrogen sensing capability under 99% relative humidity.
- The developed optical fiber H₂ sensor showed negligible cross-sensitivity to CH₄.
- Planning to coat a protective layer over the Pd/SiO₂ sensing layer to improve H₂ selectivity and sensitivity under the harsh environment of subsurface storage.

Conclusions and Next Steps

- Developed the multi-elements surface acoustic wave sensor capable of sensing CH₄ and CO₂.
- Demonstrated gas sensing capability under 43% relative humidity in wireless mode.
- Currently exploring different types of polymer and sorbent to improve sensitivity to methane gas.
- Planning to optimize the SAW configuration and coating sensing layers to maximize methane sensitivity under humid condition.