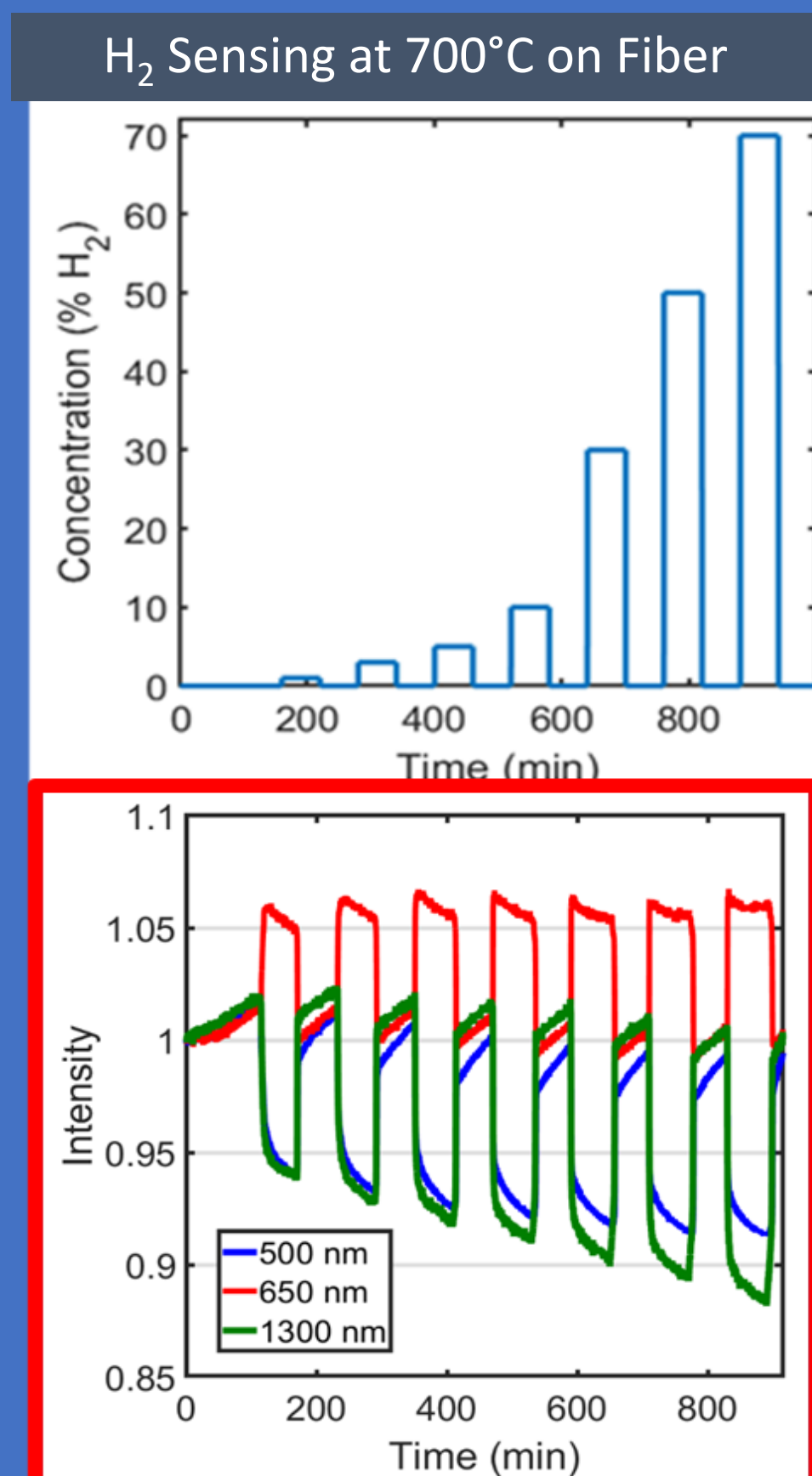
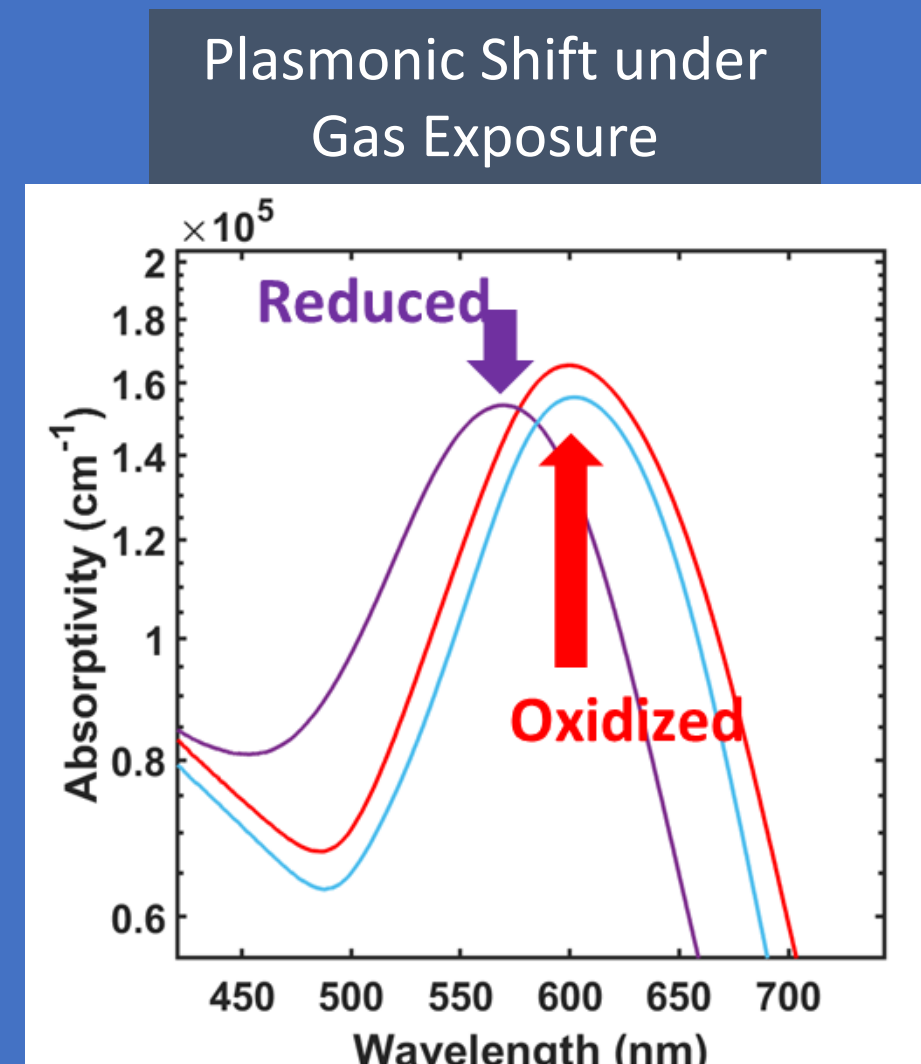
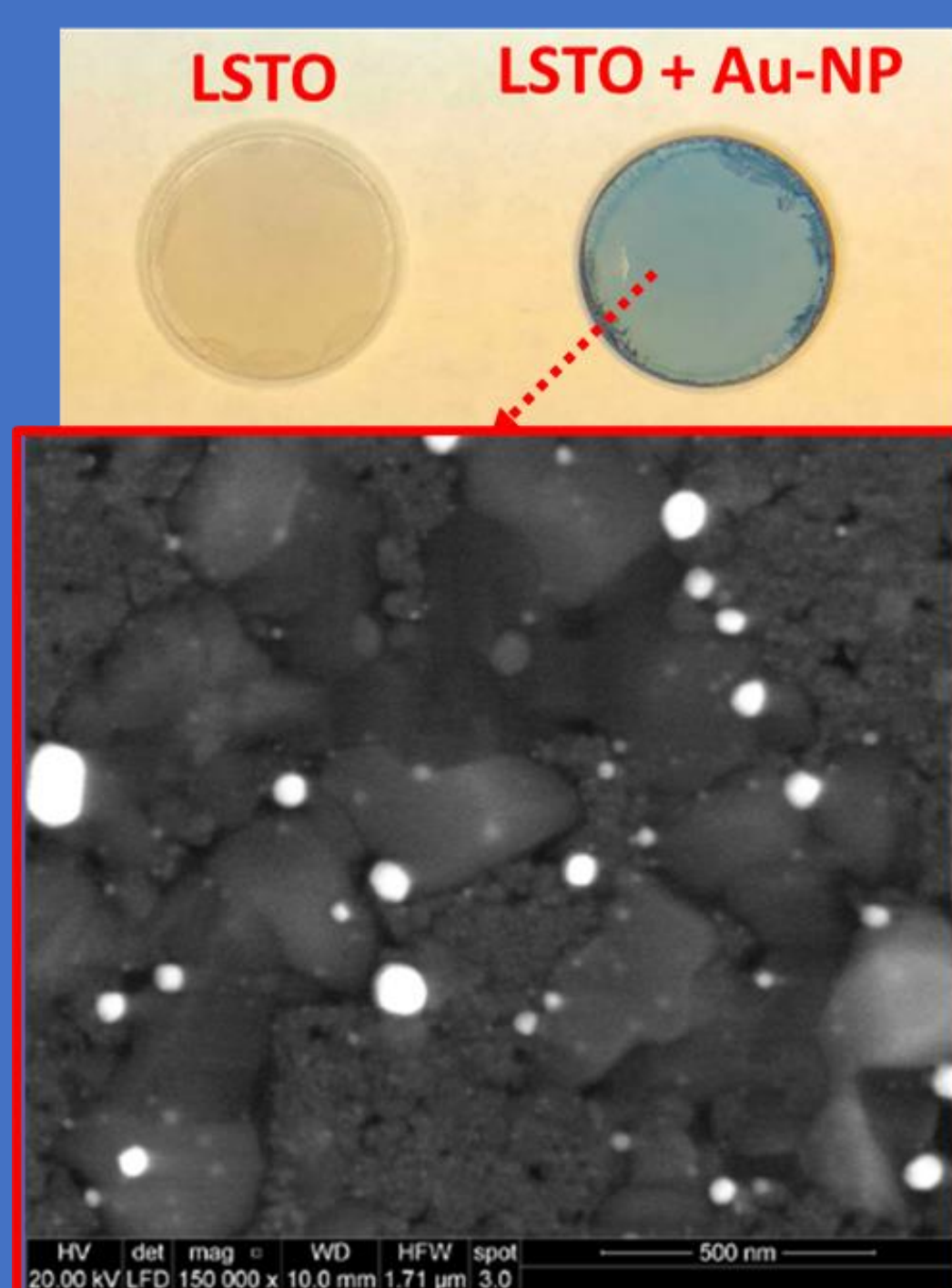


Nanocomposite Films for Energy Infrastructure Sensing Applications on Optical Fiber

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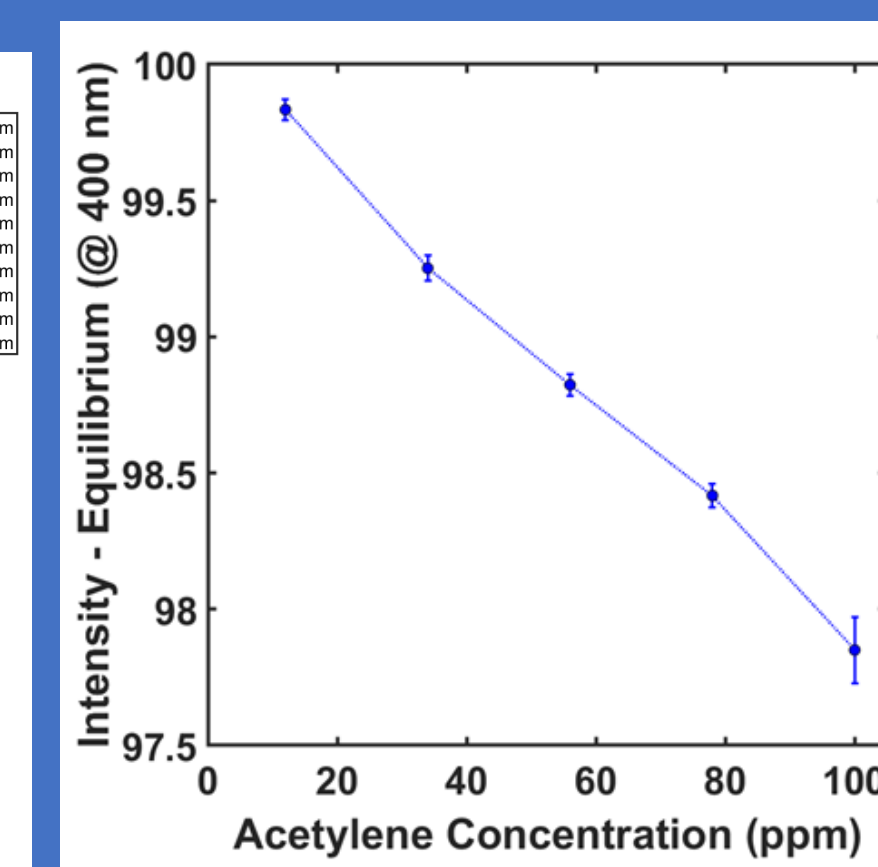
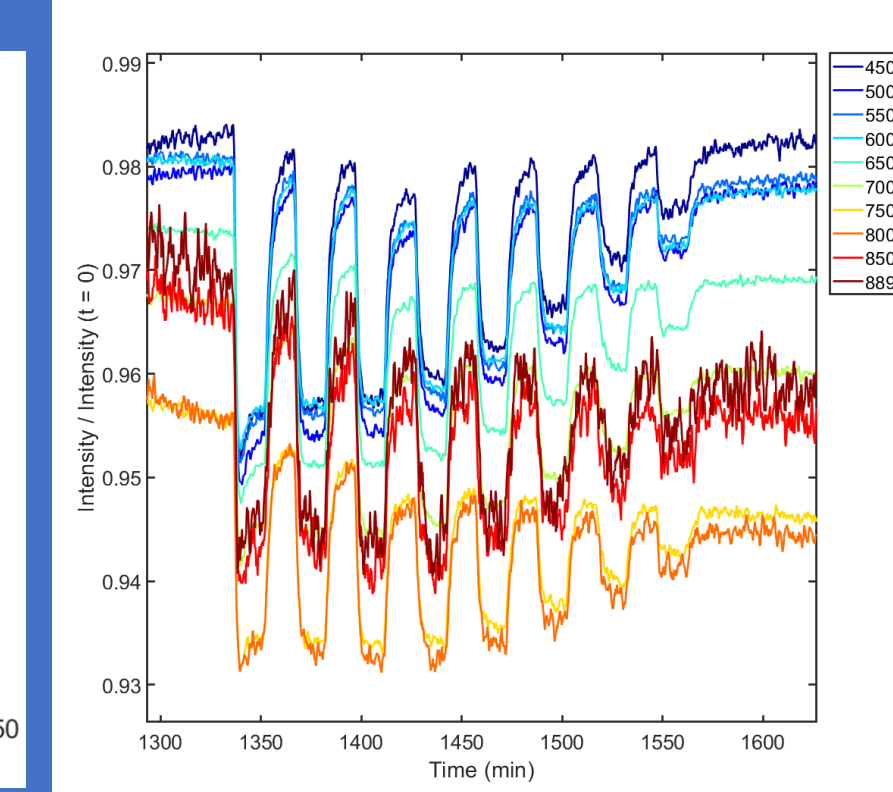
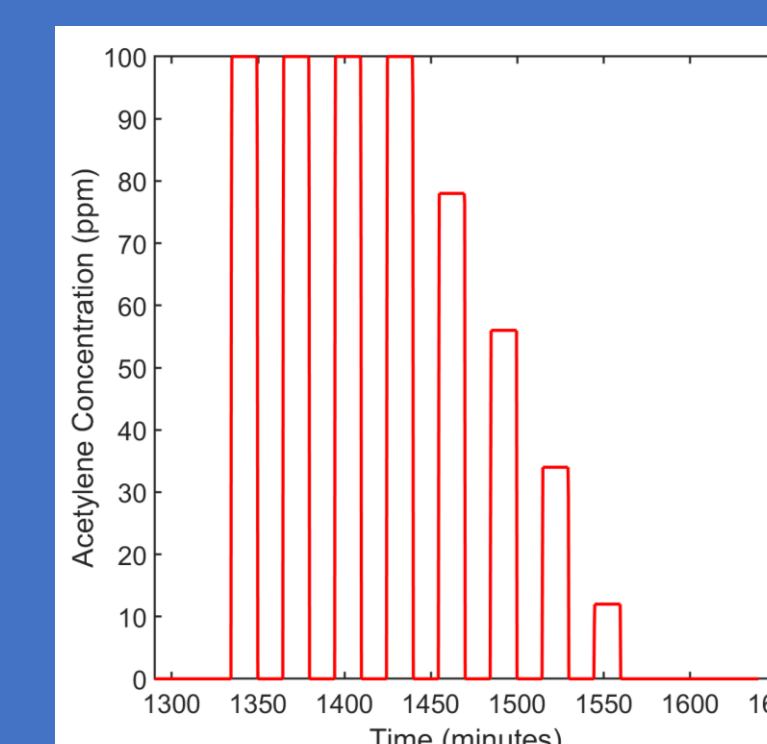
High Temperature Plasmonics for Gas Sensing [1,2]



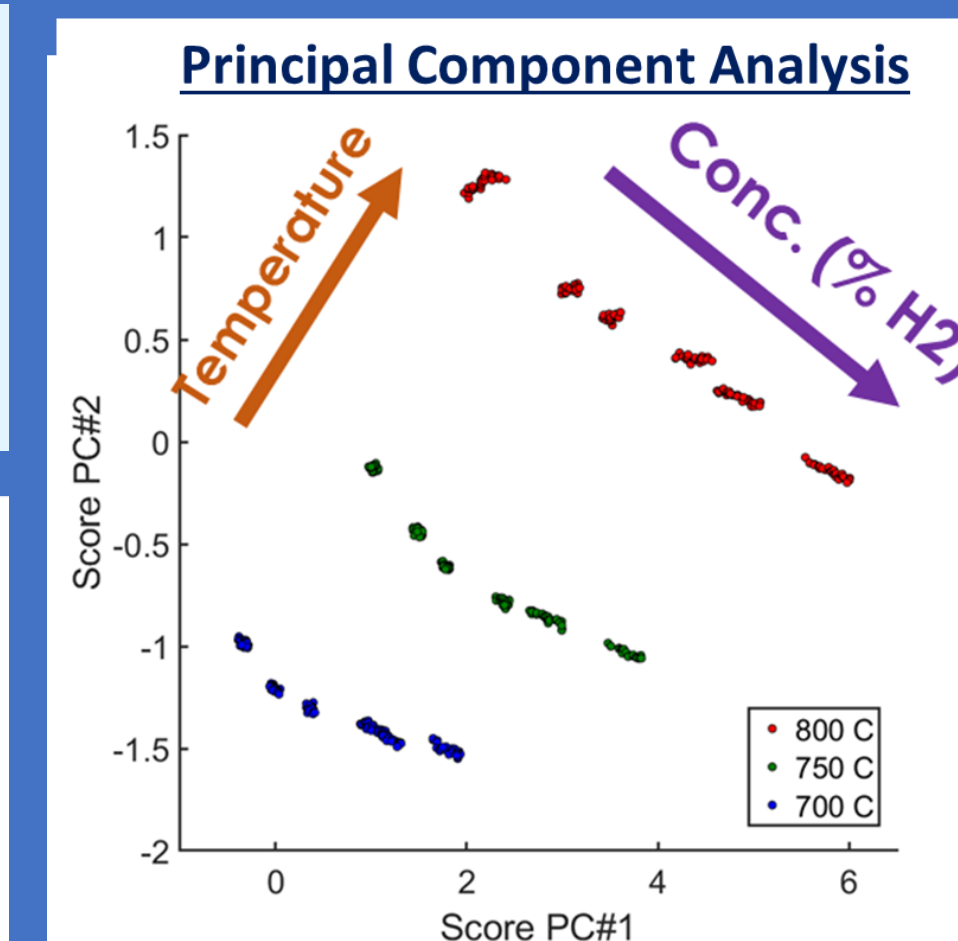
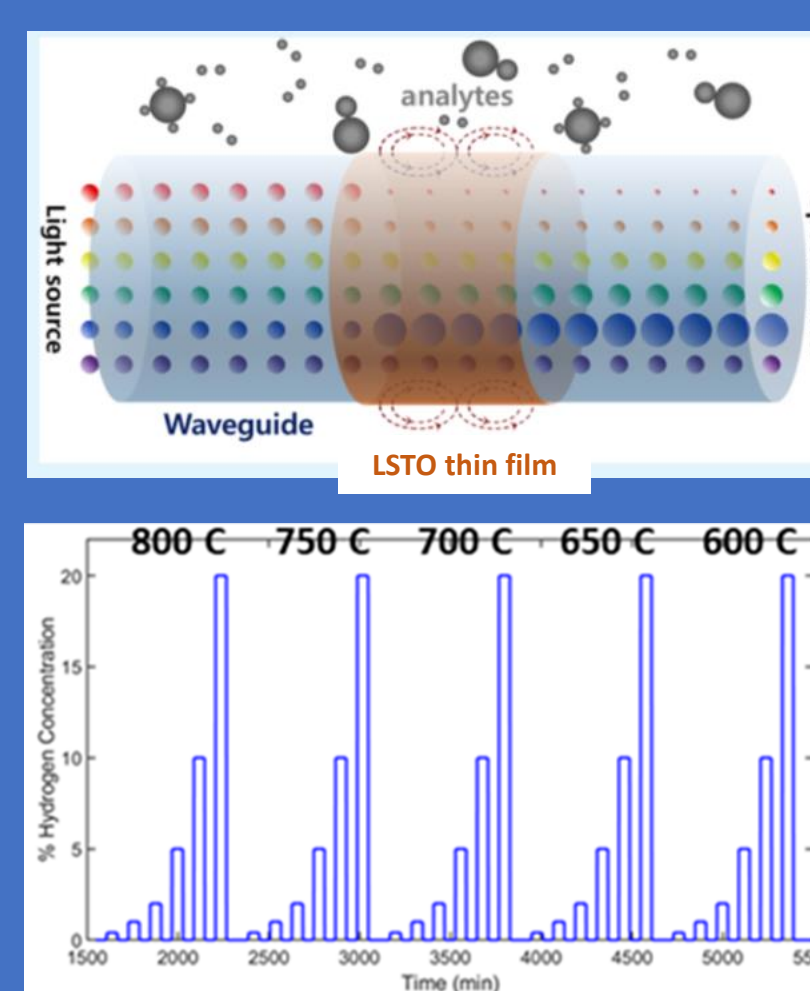
- Combined conducting oxide / plasmonic films interact with oxidizing reducing gas streams at high temperature.
- Optical signatures in visible and near-infrared can be used for oxygen or fuel gas sensing at high temperature (>500°C).
- Applications: solid oxide fuel cell monitoring (anode, cathode); monitoring of H₂, CH₄; and post-combustion oxygen monitoring.
- Areas of current interest: implementation with scalable single crystal fiber for extreme temperature environments (>1000°C), distributed sensing with silica or single crystal fiber (i.e., with optical time domain reflectometry, OTDR).

Ni/Silica Nanocomposite Sensing Layers for Transformer Monitoring [3]

- Presence of acetylene dissolved in oil-filled transformers is indicative of discharge faults.
- Dissolved gas analysis (DGA) of collected oil samples is the gold standard for discharge fault detection.
- Optical fiber-based sensors desired to operate in-situ and provide real-time feedback.
- Areas of current interest – distributed sensor development. Multi-variate sensor of relevant combustible gas species (“photonic nose”).



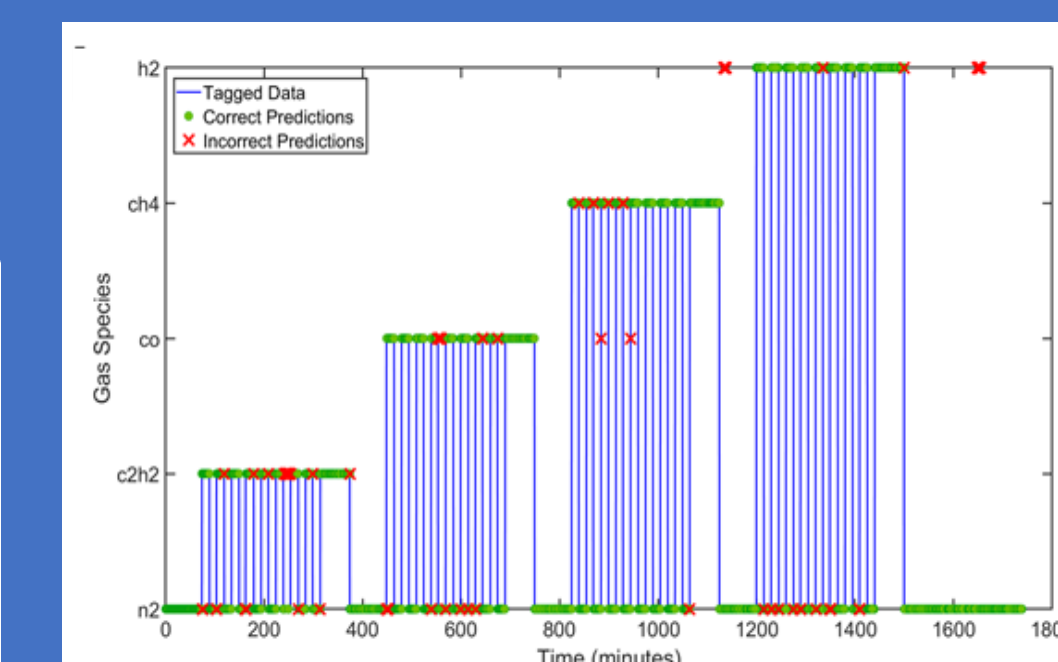
Multi-Variate Discrimination with Machine Learning [1,3]



Support Vector Machine (SVM)
Training with Spectral Data

Confusion Matrix (Fine Gaussian SVM)

True class \ Predicted class	c2h2	ch4	co	h2	n2
c2h2	667	2	64		
ch4		679	2	31	
co	2		658	1	55
h2	1		5	655	71
n2	58	9	25	60	3912



- Nanocomposite films can be tuned to include multiple sensing mechanisms for multiple gas species, temperature, and pressure.
- Broadband or multi-wavelength interrogation is easy to implement on optical fiber.
- AI/ML techniques can extract multi-variate information from feature-rich spectral data.

References

- [1] Wuenschell, et al. *Nanoscale* 12.27 (2020): 14524-14537.
 [2] Wuenschell, et al. *MRS Communications* (2022): 1-7.
 [3] Wuenschell, et al. *Fiber Optic Sensors and Applications XVIII*. Vol. 12105. SPIE, 2022.

Disclaimer

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