Pd/PMMA nanocomposite coated fiber optic hydrogen sensor

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Material Characterization

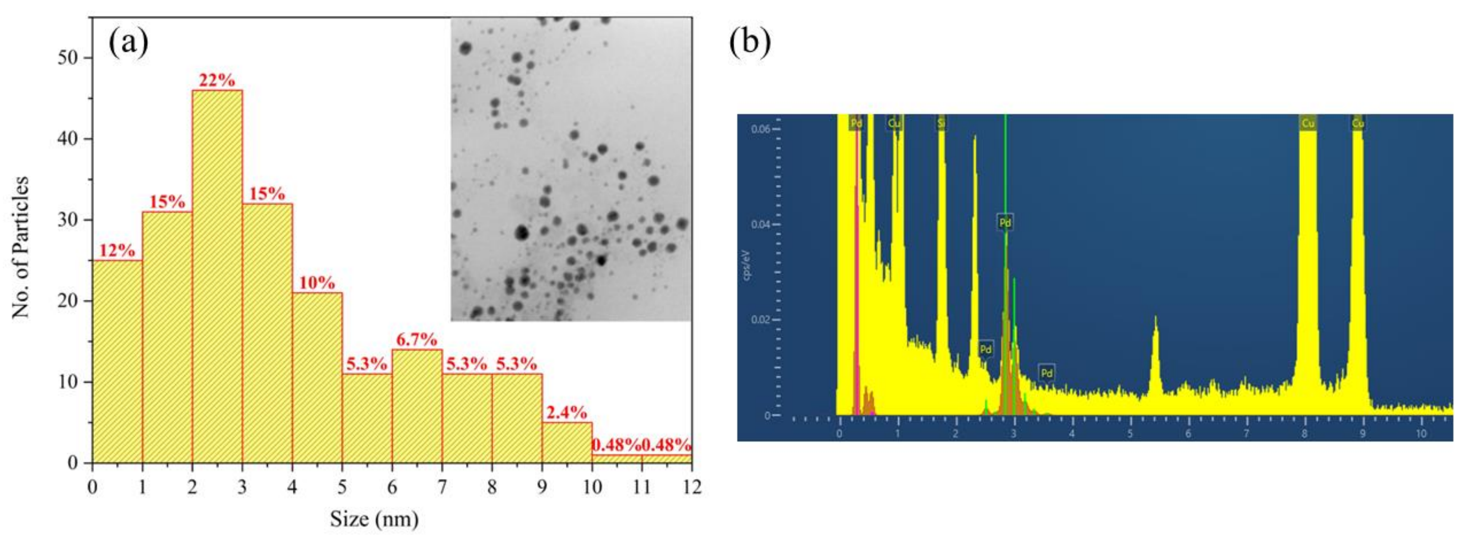

Fig.1 (a) Particle size distribution analysis (b) STEM-EDS mapping of segregated Pd NPs

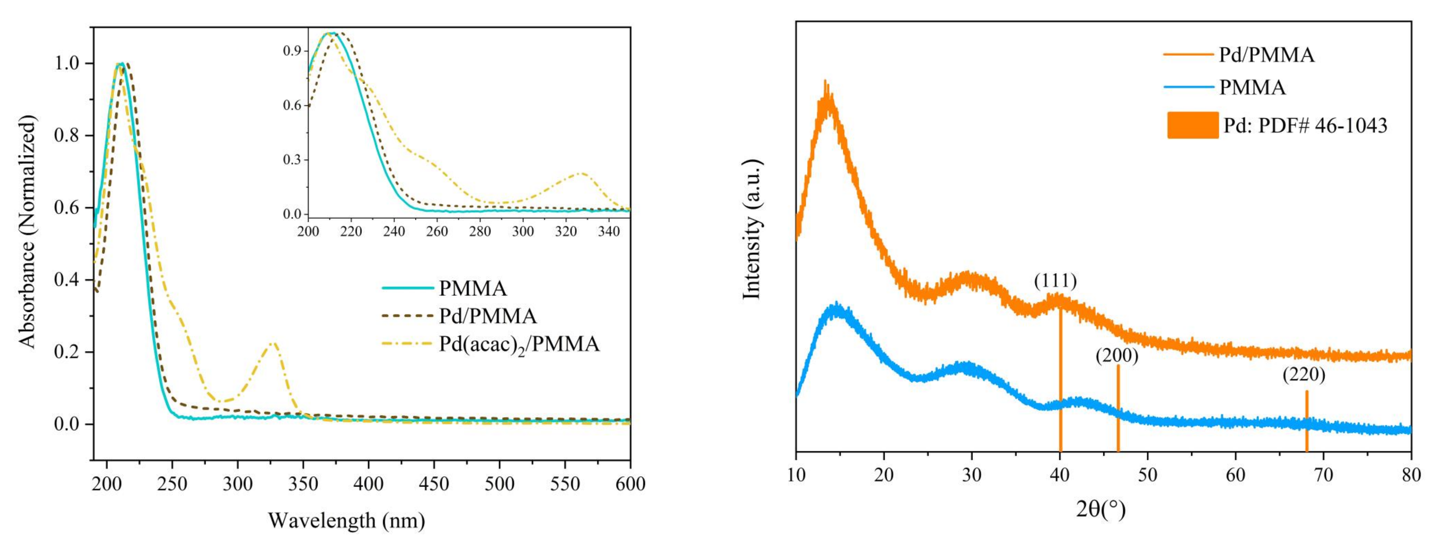

Fig. 2. UV-VIS spectroscopic analysis (left), GI-XRD spectra of the composite material (right)

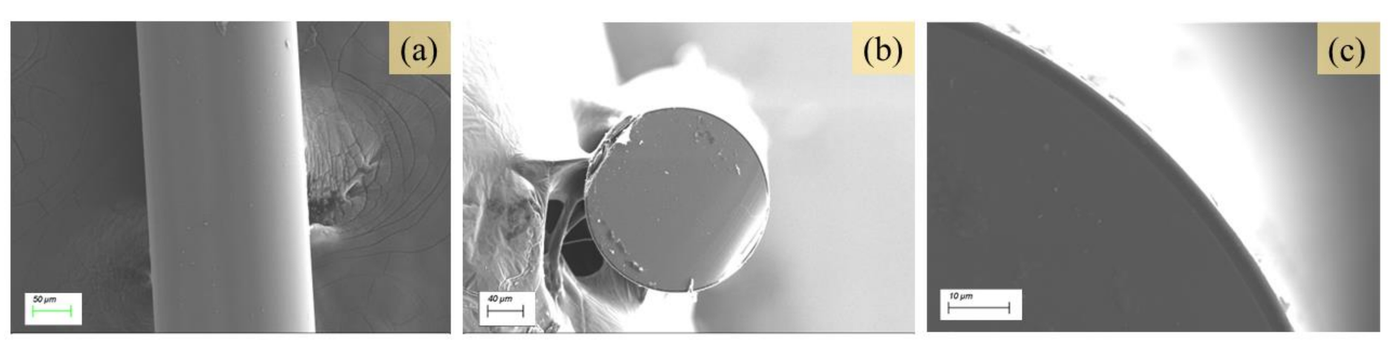

Fig. 3. FESEM images of coated fiber surface (a), cross section (b), and zoomed view cross section

- Microscopic analysis of the nanocomposite indicate the existence of well dispersed ultrafine Pd NPs without large aggregates, most particles (74%) are less than 5 nm in size
- The coated fiber surface appears smooth and homogeneous with no particulates. The cross-sectional image indicates conformal coating with thickness of ~ 2.8 µm

Overview and Highlights

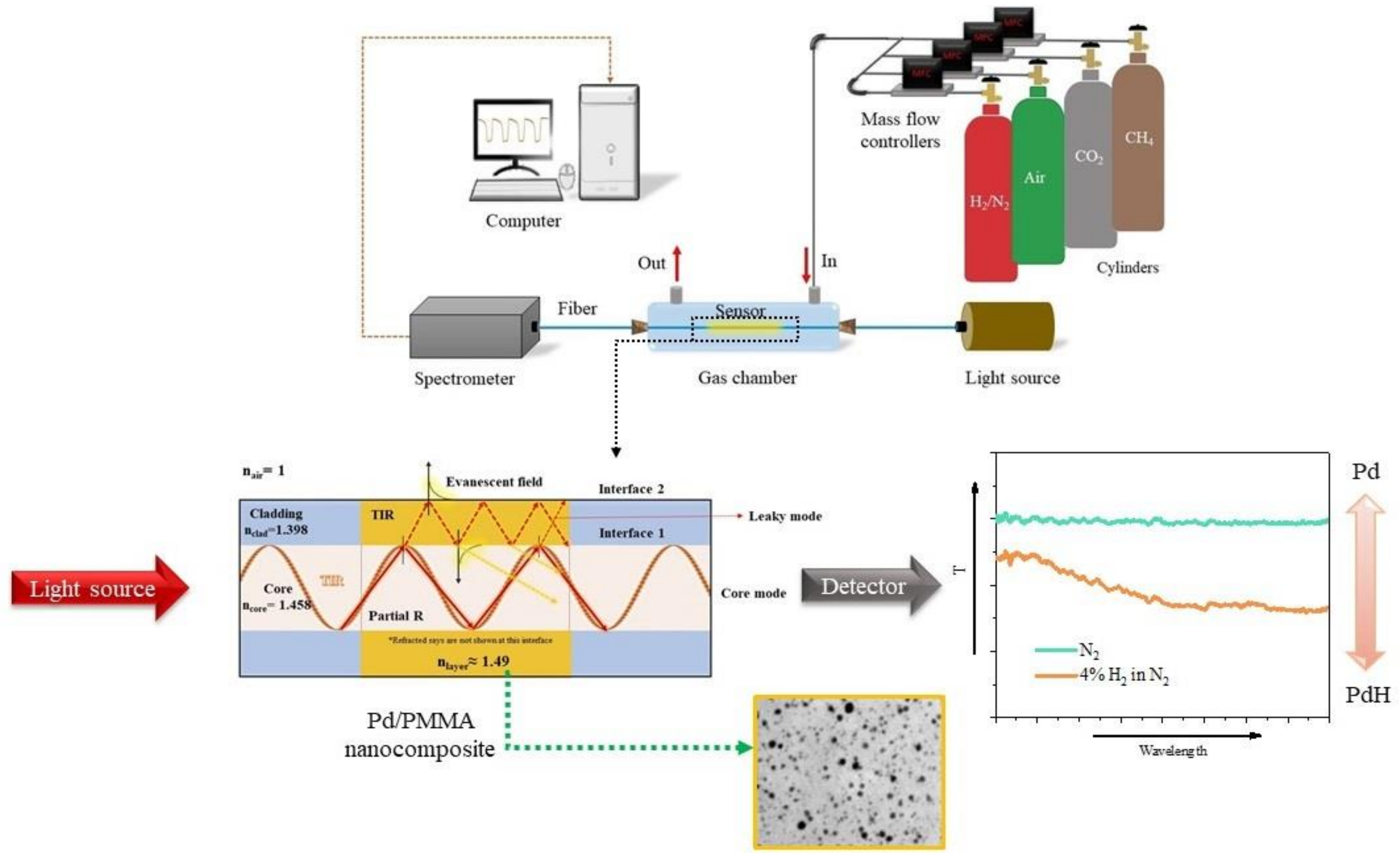

Fig. 4. Graphical abstract

- A fiber optic hydrogen sensor coated with a palladium/polymethyl methacrylate (Pd/PMMA) nanocomposite layer is fabricated and benchmarked here.
- The sensor with Pd/PMMA substituted cladding, operates by intensity modulation technique through partial reflection in the sensing region.
- In-situ thermal reduction method has been adopted for nanocomposite synthesis due to reduced processing steps required and to avoid material waste.
- The feasible and cost-effective sensor preparation protocol make the sensor a competitive candidate for hydrogen gas monitoring applications that operate at near room temperatures.

Reference : 10.1109/JSEN.2024.3454569

Fiber optic sensor Characterization

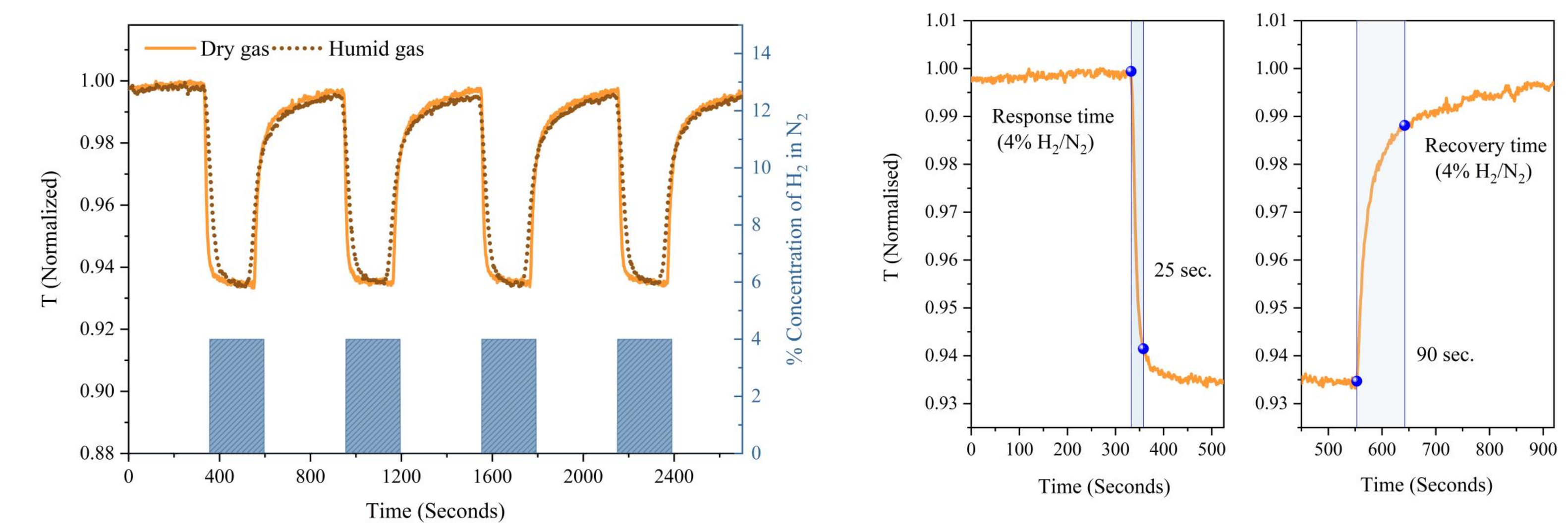

Fig. 5. (L) Response to 4% H_2/N_2 (R) Response and recovery time towards 4% H_2/N_2 under dry gas condition

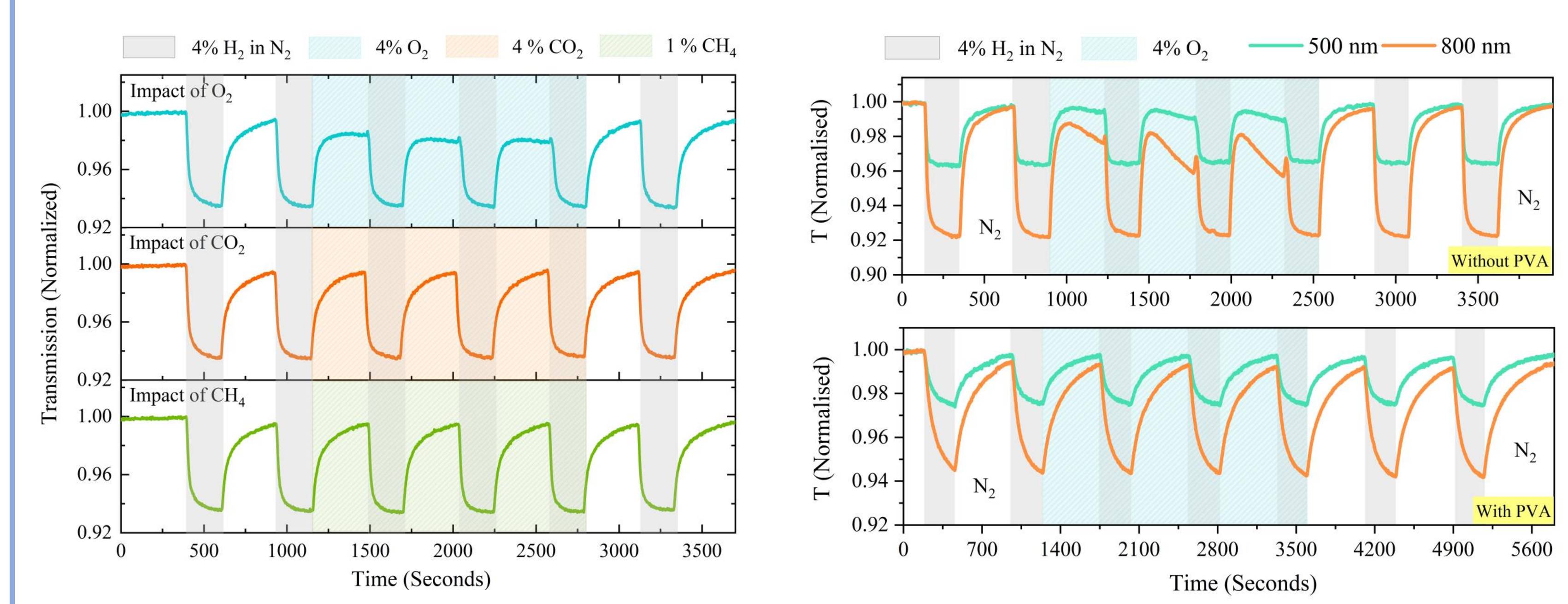

Fig. 6. (L) Sensor response in presence of interfering gases (R) Before and after coating with secondary PVA layer in response to changing gas composition

- Excellent humidity resistance
- Good environmental stability in presence of interfering gases.
- Response time of 25 sec to 4% H_2.
- Can detect low H_2 concentration, down-to 0.1%

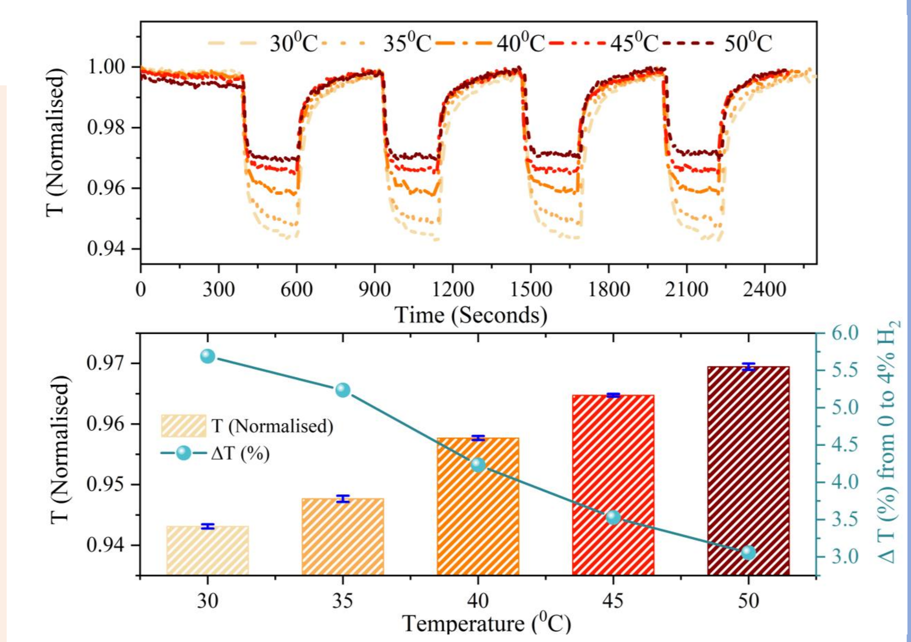

Fig. 7. H_2 sensing response (4%) at different temperatures

However, presence of O_2 and increased temperature contributes to lowering the sensing response which could again be restored once the sensor is moved to inert environment at room temperature.

Acknowledgement

This material is based in part upon work supported by sponsored research project between BrainDrip LLC and University of Pittsburgh. Specifically, a subset of material synthesis and device testing of Pd / PMMA sensing layers for H_2 concentration and humidity were supported by the Braindrip LLC sponsored research project. The authors also acknowledge funding support from U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Solar Energy Technologies Office Award Number DE-EE0009632 and the US DOE NEUP program under work package #NU-21-PA-PITT-040101-05 which supported the remainder of the work