# Supporting Information

# Developed Low Temperature Anionic 2H-$MoS_2$/Au Sensing Layer Coated Optical Fiber Gas Sensor

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"Characterization Techniques were performed by the listed instruments: FESEM: Sigma VP model of Germany ZEISS company, EDS: oxford instruments of England, Mapping: oxford instruments of England, DRS: UV-2550 model of Japan Shimadzu company, FTIR: Spectrum Two from Perkin Elmer company) in the wavelength range of 4,000 to 400 $cm^{-1}$ and TEM: ZEISS-EM10C-100KV Germany. X-ray powder diffraction (XRD) pattern was operated on a X'Pert pro of Panalytical company Japan RigakuD/Maxr-A X-ray diffractometer equipped with graphite monochromatized high-intensity Cu K radiation (λ= 1.54178Å) in the 2θ range ($10^{O}$ - $80^{O}$) at a scanning rate of 2o $min^{-1}$"

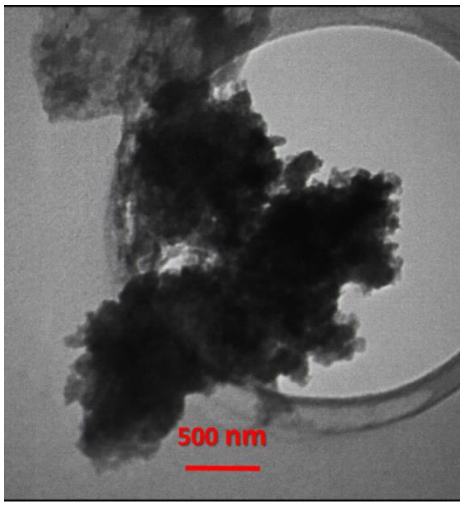



**Figure S1** TEM analysis of pristine $MoS_2$ nanoparticle integrated nanosheets.

It should be noted that Au is an inert metal, and its adhesion onto polymeric surfaces is notoriously poor. The relatively strong cohesive forces holding the Au atoms together prevent chemical bonding between the adsorbed metal atoms and the polymer surface [1-3]. Due to these, the metallization of Au onto polymeric substrates (poly (methyl methacrylate)) is a big challenge into the field of fabrication of sensors and optoelectronic elements. To overcome this limitation, we deposit Au thin film by the magnetron sputtering which is ideally suited for scanning electron microscopy (SEM) specimen preparation.

**Table 1S**. Synthesis conditions of the samples considered here.

| Sample | $Na_2MoO_4.2H_2O$ (M) | $C_2H_5NS$ (M) | $C_6H_8O_7.H_2O$ (M) | Temperature (°C) |
|---|---|---|---|---|
| C1 | 0.0256 | 0.1 | 0.0418 | 80 |
| C2 | 0.0512 | 0.2 | 0.0837 | 80 |
| C3 | 0.0768 | 0.3 | 0.1256 | 80 |
| T1 | 0.0768 | 0.3 | 0.1256 | 60 |
| T2 | 0.0768 | 0.3 | 0.1256 | 70 |
| T3 | 0.0768 | 0.3 | 0.1256 | 80 |

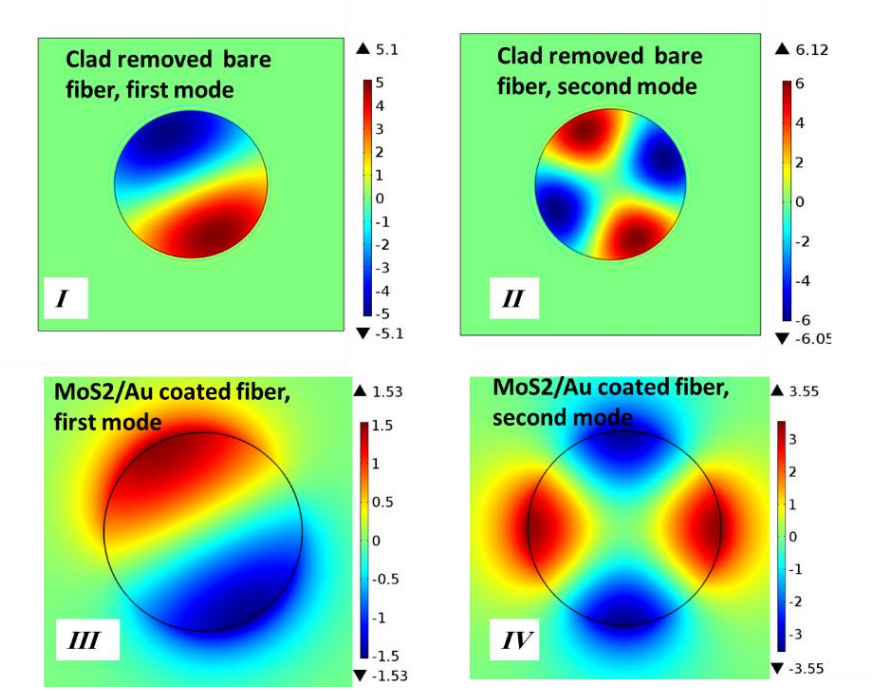



**Figure S2** Surface diagram of z-component of electric field distribution of the fundamental first and second modes within the clad removed bare fiber (*I*, *II*) and the proposed sensing layer $MoS_2$/Au coated fiber (*III*, *IV*), respectively.

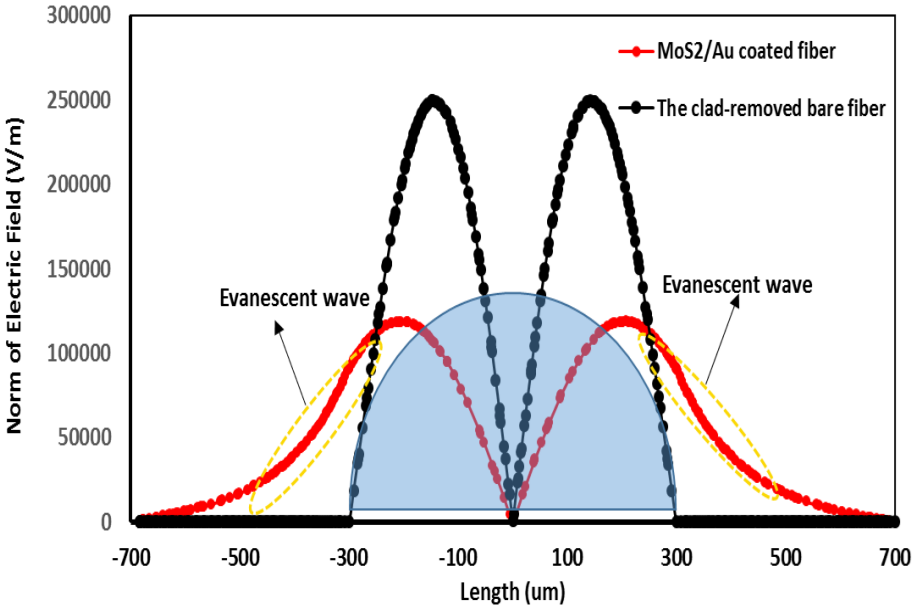



**Figure S3** The line graph of the norm electric field distribution and evanescent wave leakages from core into the surrounding environment interface.

As shown in Fig.S2 and Fig. S3, the sensing performance of Au coated optical fiber was also studied under ambient humidity variations. The obtained dynamic and sensitivity response revealed that for RH more than 70% the sensing behavior is not linear and significant trend. Also the sensitivity response compared with the $MoS_2$/Au coated optical fiber revealed less sensitivity with lower slope of intensity variation. It is worth noting that the spectrum of source itself has two main peaks.

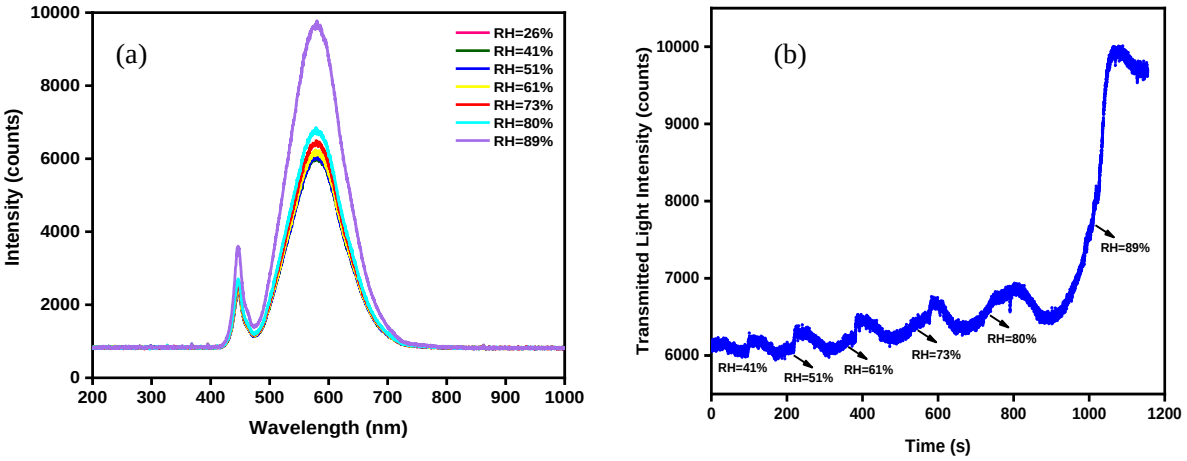



**Figure S4 (a)** The spectrum and (b) dynamic response of the bare clad removed polymer optical fiber in exposure to the different relative humidity condition.

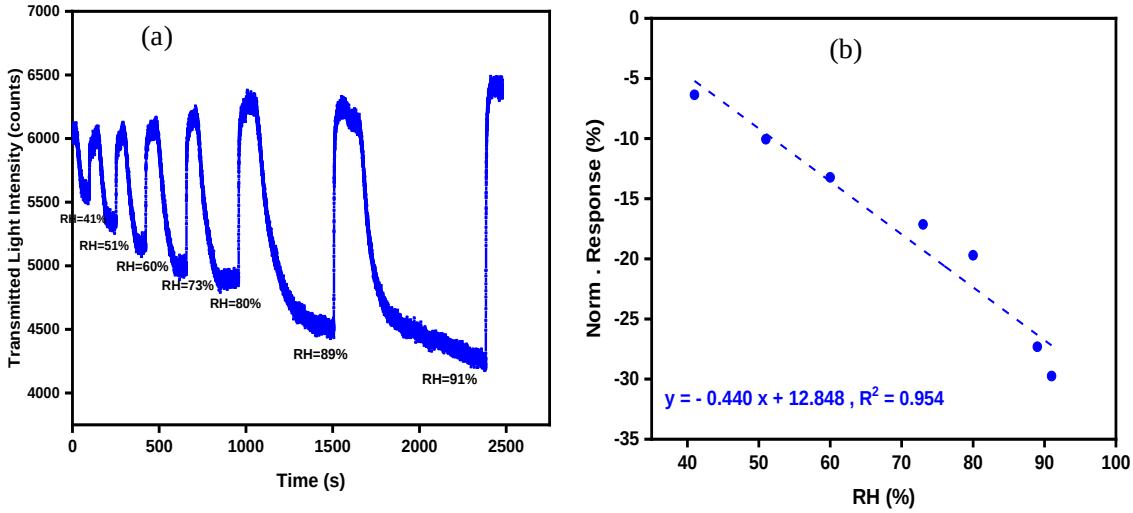
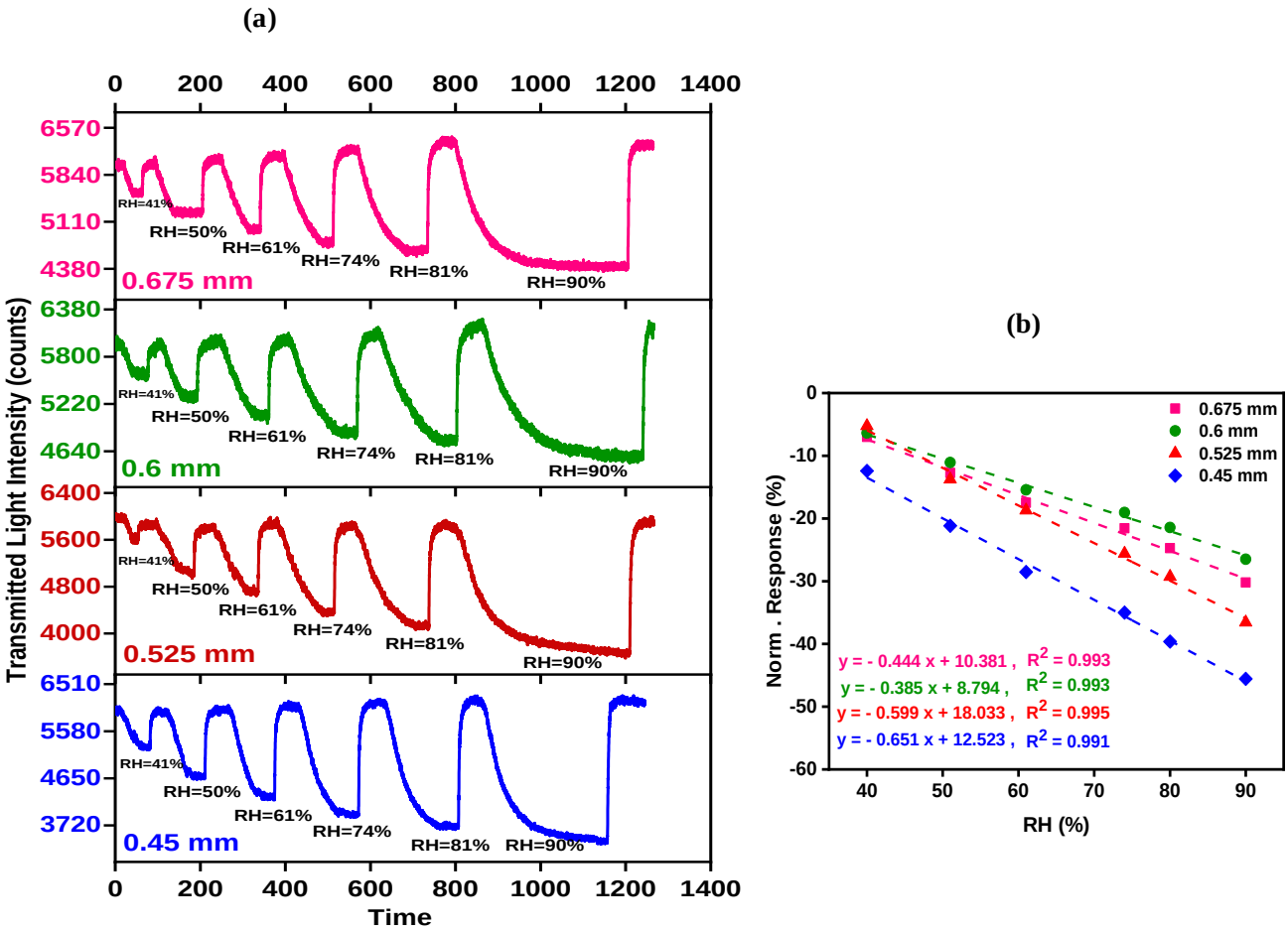



**Figure S5** The dynamic (a) and sensitivity (b) response of the optical fiber sensors modified with Au layer.

The optimized anionic 2H-$MoS_2$/Au coated optical fiber sensor response for different diameters of unclad optical fiber were illustrated in Fig. S6.



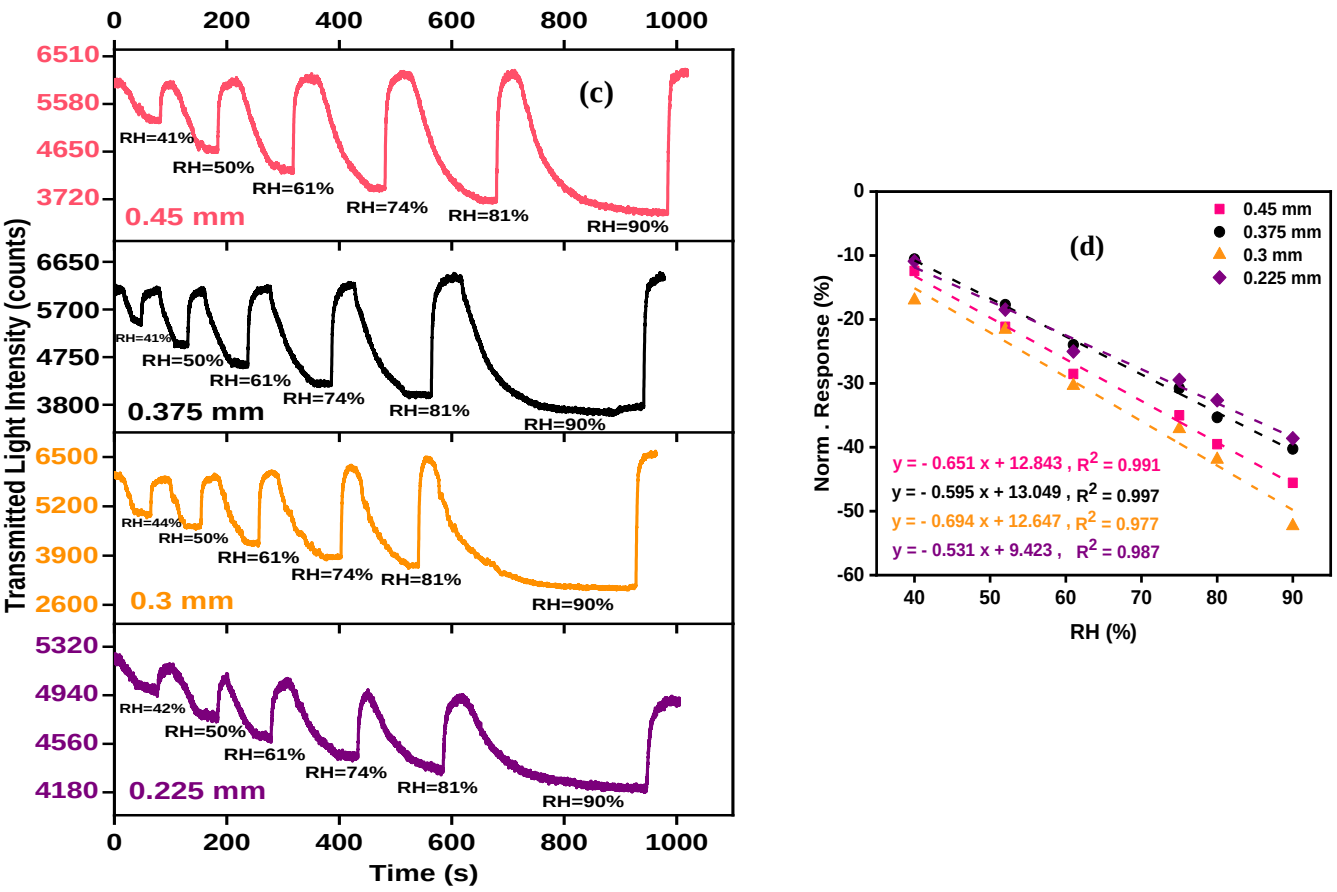



**Figure S6** The dynamic (a & c) and sensitivity (b & d) response of anionic 2H-$MoS_2$/Au coated the optical fiber sensors modified with different optical fiber diameters of 0.675, 0.6, 0.525, 0.45, 0.375, 0.3, 0.225 mm.

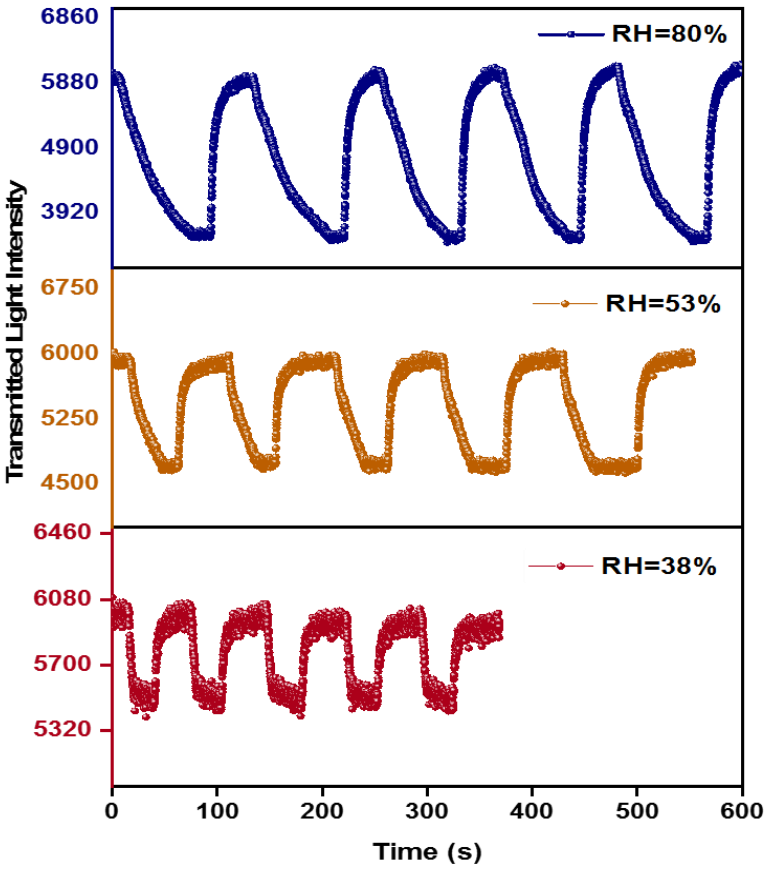



**Figure S7** the repeatability and stability of the prepared anionic 2H-$MoS_2$ coated optical fiber was tested after 65 days.

## Supporting Reference:

[1] Mo, A. K.; Brown, V. L.; Rugg, B. K.; Devore, T. C.; Meyer, H. M.; Hu, X.; Hughes, W. C.; Augustine, B. H. Understanding the Mechanism of Solvent-Mediated Adhesion of Vacuum Deposited Au and Pt Thin Films onto PMMA Substrates. Adv. Funct. Mater. 2013, 23, 1431-1439. DOI: 10.1002/adfm.201201955.

[2] Li, W. T.; Charters, R. B.; Luther-Davies, B.; Mar, L. Significant Improvement of Adhesion between Gold Thin Films and a Polymer. Appl. Surf. Sci. 2004, 233, 227-233. DOI: 10.1016/j.apsusc.2004.03.220.
[3] Mo, A. K.; Devore, T. C.; Augustine, B. H.; Zungu, V. P.; Lee, L. L.; Hughes, W. C. Improving the Adhesion of Au Thin Films onto Poly (Methyl Methacrylate) Substrates Using Spun-Cast Organic Solvents. J. Vac. Sci. Technol., A. 2011, 29. DOI: 10.1116/1.3562167.