Optical fiber coated Zinc Oxide (ZnO) nanorods decorated with Palladium (Pd) for hydrogen sensing

Nur Farahi Idris[a], Nor Akmar Mohd Yahya[b], Mohd Hanif Yaacob[b], Auni Hamimi Idris[c]. Sulaiman Wadi Harun[d], Norazlina Saidin[a]

[a] Department of Electrical and Computer Engineering, International Islamic University Malaysia, 53100, Kuala Lumpur, Malaysia
[b] Photonics System Engineering Laboratory of University Putra Malaysia, 43300, Seri Kembangan, Selangor, Malaysia
[c] Faculty of Chemical Engineering and Natural Resources of University Malaysia Pahang, 26300, Kuantan, Pahang, Malaysia
[d] Department of Electrical Engineering, University of Malaya, 50603, Kuala Lumpur, Malaysia

ABSTRACT

A novel hydrogen (H_2) sensor was developed using acid-etched optical fiber coated with zinc oxide (ZnO) nanorods. The sensing performance was done by comparing the acid-etched fiber coated with ZnO nanorods with and without decorated Palladium (Pd). The conventional optical single-mode fiber (SMF) with a diameter of 125 µm has been modified as a transducing platform by etching it to 11 µm diameter using hydrofluoric acid (HF) to enhance the evanescent field of the light propagates in the fiber core. The etched fiber was coated with ZnO nanorods via hydrothermal process by using seeding and growth solution method. The sensing layer was characterized through Scanning Electron Microscopy (SEM), Energy Dispersive X-Ray (EDX) and X-Ray Diffraction (XRD) to verify the properties of ZnO. Catalyst Palladium (Pd) was sputtered onto the ZnO nanorods to improve H_2 detection. The developed sensor operating temperature was found to be 150 °C that produces 6.36 dBm increase in response towards the 1% concentration of H_2 in synthetic air. It was then tested with different concentration of H_2. The sensor decorated with Pd has better performance in sensing compared to non-decorated Pd based on the output power versus time. The sensor best response and recovery times is 6 and 5 min respectively, for acid-etched optical fiber coated with ZnO nanorods decorated with Pd for 0.75% of H_2 concentrations at 150 °C. The results indicate the optical fiber sensor might improve the performance towards H_2 as oppose to the conventional electrical sensor.

KEYWORDS
Hydrogen sensor; Etching optical fiber; Fiber optic sensor; Light-intensity; response; Zinc oxide nanorods; Hydrothermal method

ACKNOWLEDGMENT
This work was supported by the Ministry of Higher Education (MOHE), Malaysia, Fundamental Research Grant Scheme (FRGS) (Grant No.: FRGS19-052-0660).