

P3HT-coated coreless silica fiber for in-line photodetection

Duc Minh Nguyen^{1,2}, Zilong Wang¹, Long Cui¹ and Cesare Soci¹

¹. Centre for disruptive photonic technologies, Nanyang technological University, Singapore, 637371

². CINTRA CNRS/NTU/THALES, UMI 3288, Research Techno Plaza, 50 Nanyang Drive, Border X Block, Level 6, Singapore 637553

Integration of multiple electronic and optical functions in a compact device has been the focus of intense research in various optical fields. In the field of telecommunications, it is interesting to integrate photodetectors into optical fibers for diagnostics, where optical signal power can be tracked at any desired position within a network without disturbing signal transmission.

Here we report the application of embedded photo-detectors using coreless silica fiber coated by a thin active layer of photoconductive polymer poly(3-hexylthiophene) (P3HT) [1]. The device structure is shown in Fig. 1a. A thin layer of P3HT (1 μm) is uniformly coated around the fiber by spin coating, and two gold electrodes with distance of 0.1 mm are then deposited on the P3HT layer by the thermal evaporation. Since the refractive index of P3HT is much larger than that of silica, the optical signal will leak into the P3HT layer while propagating along the fiber, generating photoconductive signal in the active P3HT layer. Photocurrent was measured for different input laser wavelengths and powers at an applied bias of 40 V between the electrodes. Fig.1b presents the resulting current-voltage (I-V) characteristics for 3 different illumination conditions: no light (dark current) and monochromatic light at 530 nm with intensities of 3.8 mW/cm^2 and 0.13 W/cm^2 . Photocurrent increases by a factor of two at input intensity of 0.13 W/cm^2 , compared to the dark current. Spectral response of the photocurrent is measured and presented in Fig. 1c. The threshold wavelength of 650 nm is consistent with the HOMO-LUMO gap of P3HT.

We also propose a different device configuration to enhance the photoconductive response, as shown in Fig. 1d. In this scheme, gold electrodes are entirely coated around the fiber, with an air gap as small as 1 μm . Such structure was obtained by thermal evaporation at variable angles. This configuration maximises overlap between leaky modes and active photoconductive region, as well as photo-carrier extraction, thus improving the overall efficiency of in-line photo detection.

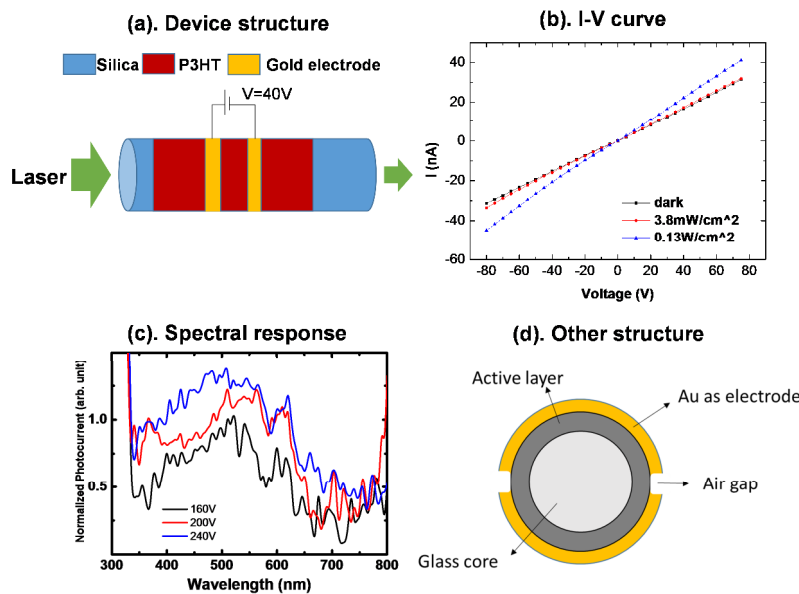


Fig. 1. (a) Scheme of fiber embedded photodetector. (b) Measured I-V curves at different light input conditions. (c) Spectral response of photoconductivity effect at different voltages. (d) Another proposed fiber embedded photodetector structure.

In conclusion, P3HT coated coreless silica fibers were fabricated and shown to work as an in-line fiber photodetector. We propose several electrode configurations that could be easily manufactured to improve photodetection sensitivity.

References

[1] Y. Li, W. Nie, J. Liu, A. Partridge, and D. L. Carroll, "The optics of organic photovoltaics: fibre-based devices", Selected Topics in Quantum Electronics, IEEE Journal of , 16 (2010), 1827-1837.