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Photoresponse and figures of merit of ZnO nanorod-polymer based hybrid UV photodiodes

Keshav Nagpal [1], Erwan Rauwel [1], Frédérique Ducroquet [2], Isabelle Gelard [3], and Protima Rauwel*[1]

[1] Estonia University of Life Sciences, Tartu, Estonia

[2] IMEP-LaHC, Micro and Nanotechnology innovation center, Grenoble, France

[3] LMGP, Micro and Nanotechnology innovation center, Grenoble, France

Introduction

- In this study, four different photodiodes (PD) were fabricated with configuration ITO/ZnO nanorods/F8BT/PEDOT:PSS/Ag.
- The ZnO nanorods were grown by using four seed layer alcohols including methanol, ethanol, isopropanol and aqueous ethanol (70%).
- The figures of merit of four photodiodes were evaluated by calculating sensitivity (S), responsivity (R), response times (T_{rise} and T_{decay}), and external quantum efficiency (EQE).

Fabrication of photodiodes

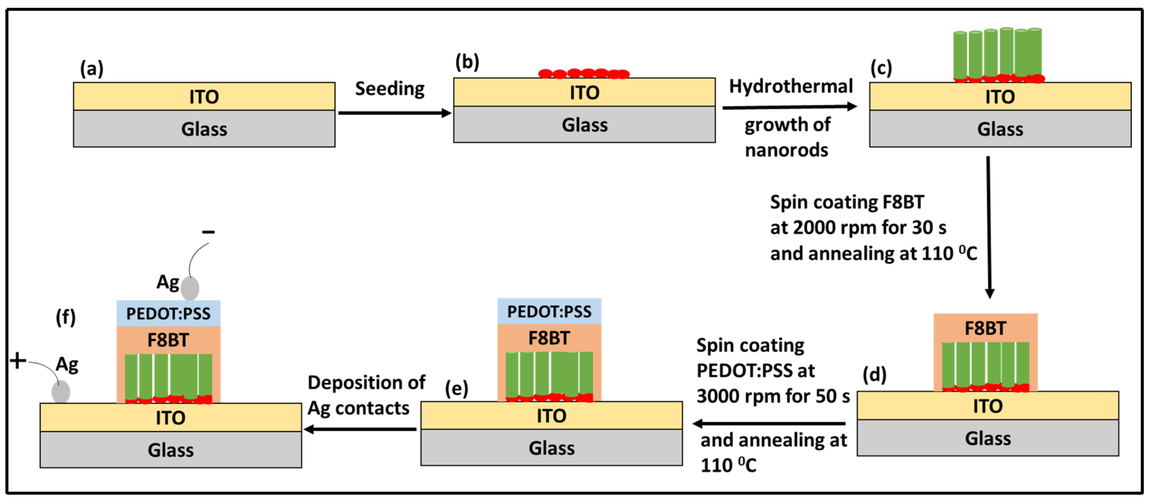

Figure.1: A schematic of the fabrication of ZnO nanorod-polymer based hybrid photodiodes.

Figures of merit of photodiodes

	Bias (-V)	S	R (A/W)	T_{rise} (s)	T_{decay} (s)	EQE (%)
PD-Methanol						
	0.1	1.24	0.08	7.7	97.1	25.2
	0.5	1.6	1.2	7.3	125.4	379.8
	1	1.9	3.15	6.6	111.8	1071.8
	2	2.5	8.14	6.6	108.3	2764.4
PD-Ethanol						
	0.1	1.4	0.01	7.6	90.2	4.2
	0.5	2.4	2.1	6.8	84.2	71.5
	1	3.5	0.8	6.2	70.6	268
	2	4.4	1.7	6.4	62.6	590
PD-Isopropanol						
	0.1	2	0.08	7.5	225.1	25.8
	0.5	1.8	1.15	7.5	147.7	391.5
	1	1.83	3.11	7.2	109.8	1054.8
	2	2.3	8.16	7.6	108.5	2773.2
PD-Ethanol(70%)						
	0.1	1.4	0.02	7.6	81	6.3
	0.5	2.3	0.3	6.7	90	99.4
	1	3.6	1	7.0	80.7	335.1
	2	3.7	1.8	7.0	69.4	603.2

Table.1: Sensitivity (S), responsivity (R), response times and EQE of photodiodes at four reverse biases of -0.1 V, -0.5 V, -1 V and -2 V.

Acknowledgement

This work was supported by ETAG Grant No. PRG 2115 and the French National Research Agency in the framework of the“investissements d’avenir” program (Grant No. ANR-15-IDEX-02).

Cross-sectional SEM image view of photodiodes

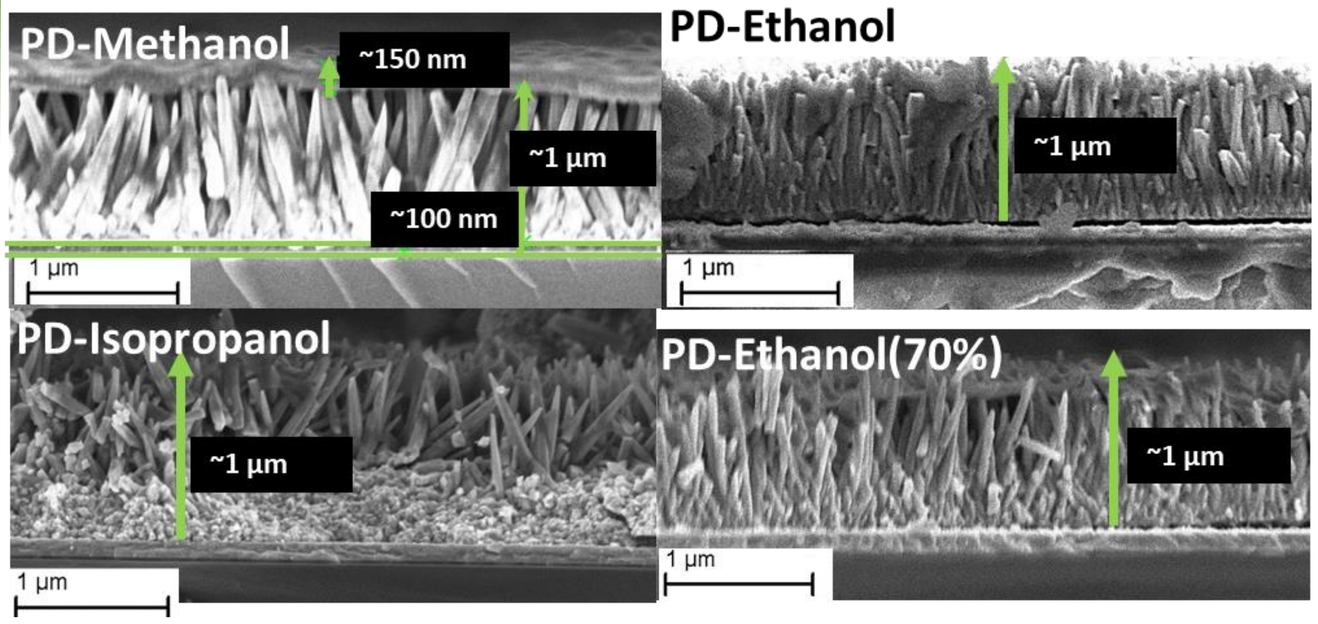

Figure.2: Cross-sectional SEM image view of photodiodes, where polymer layer is of ~130 nm thickness and nanorod layer is of ~1 µm thickness.

Electrical characteristics of photodiodes

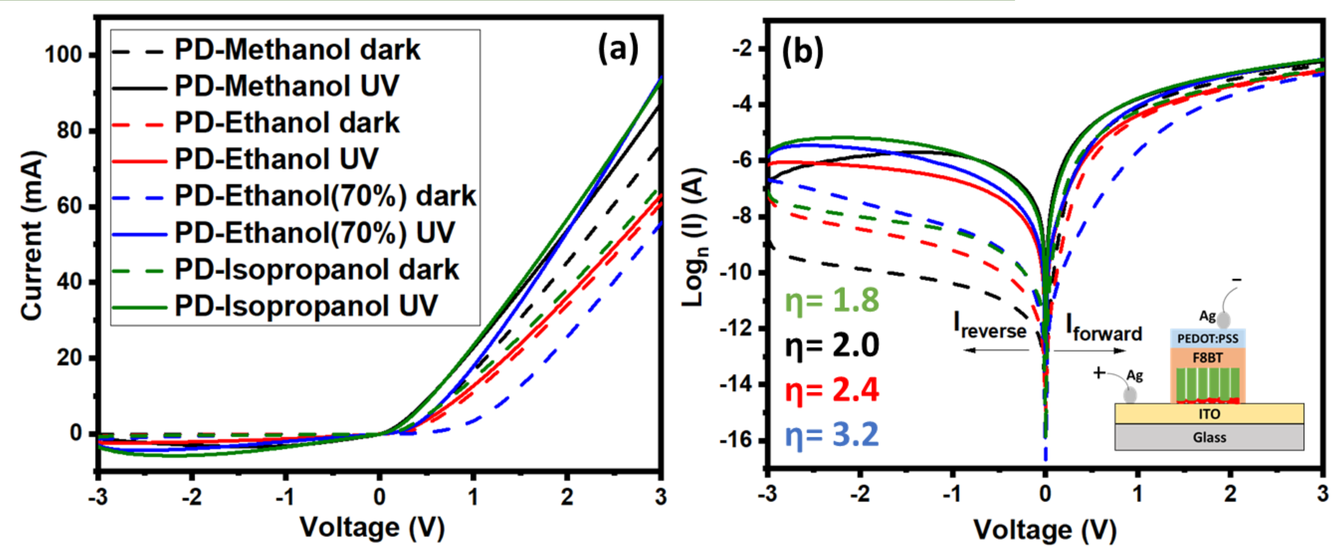

Figure.3: (a) I-V and (b) semi-log I-V characteristics of photodiodes under dark and UV light from -3 V to +3 V. An ideality factor of ~1.8, ~2.0, ~2.4 and ~3.2 was calculated for PD-Isopropnaol, PD-Methanol, PD-Ethanol and PD-Ethanol(70%), respectively from their dark semi-log I-V curves.

Photoresponse and EQE of photodiodes

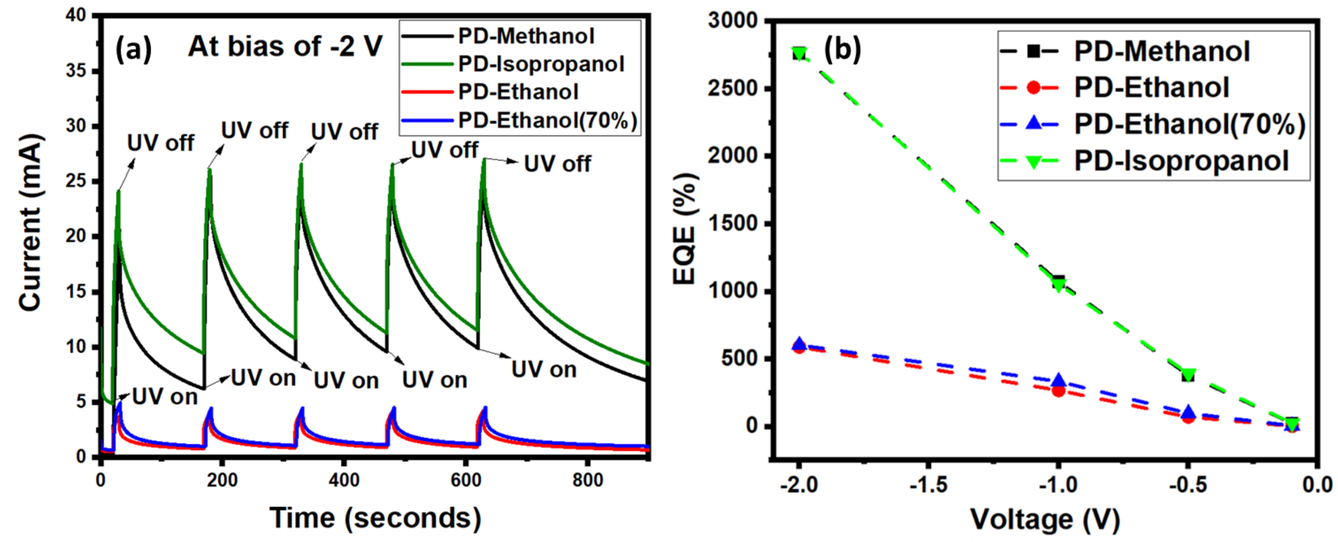

Figure.4: (a) Photoresponse of photodiodes at reverse bias of -2 V with several UV on/off cycles and (b) Comparison of the EQE of the photodiodes with respect to four reverse biases of -0.1 V, -0.5 V, -1 V and -2 V.

Conclusion

- The best performing photodiode of this study is PD-Methanol with good η of 2, good sensitivity, responsivity and highest EQE of ~2760% at reverse bias of -2 V.
- The configuration of photodiodes is a novel configuration and has never been studied before for UV radiation detection applications.

References

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Corresponding author: **Keshav Nagpal** keshavnagpal0@gmail.com, keshav.nagpal@student.emu.ee