

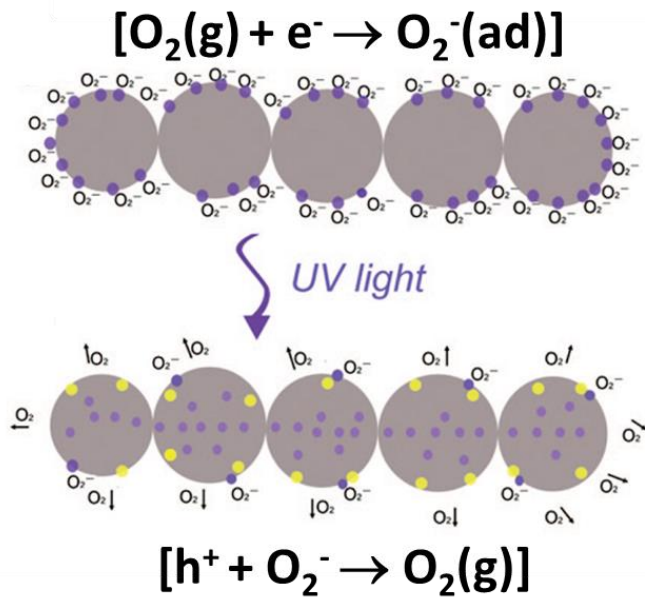
Highly sensitive wireless UV sensor platform based on aspect ratio controlled ZnO nanorods

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UV sensing mechanism of ZnO devices



- Oxygen molecules are adsorbed onto ZnO surfaces by capturing free electrons which creates a low-conductivity depletion layer
- Upon UV illumination, hole discharge the negatively charged adsorbed oxygen ions to photodesorb oxygen from the surfaces or effectively get trapped at the ZnO surfaces, resulting in an increase in the free carrier concentration

Objectives

To synthesize ZnO nanorods by solution-processing method with controlling the length of them to understand the affects of the length of ZnO nanorods on ZnO nanorods based UV sensors.

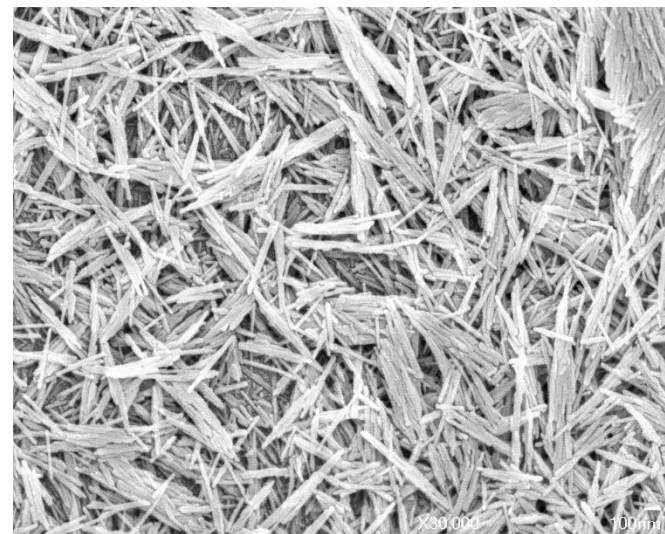
ZnO nanostructure



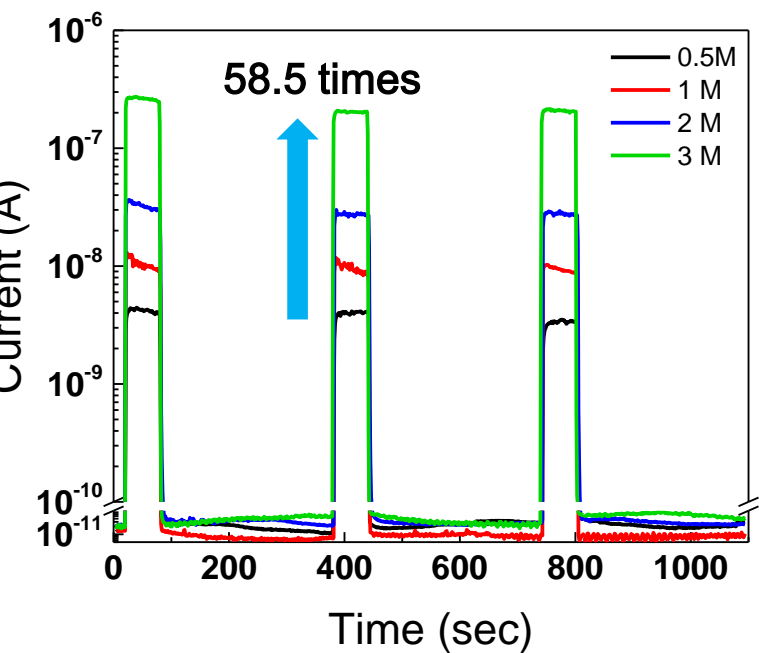
High aspect ratio



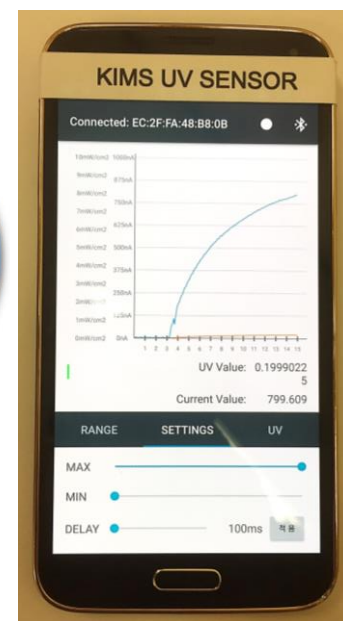
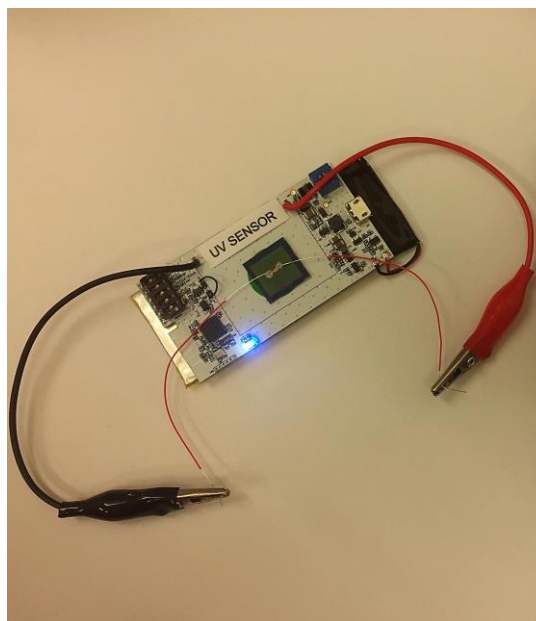
Solution processable



Fast & high sensitivity



Wireless UV sensor platform



Seeding Step

Zinc
precursor



Base
material

High
concentration

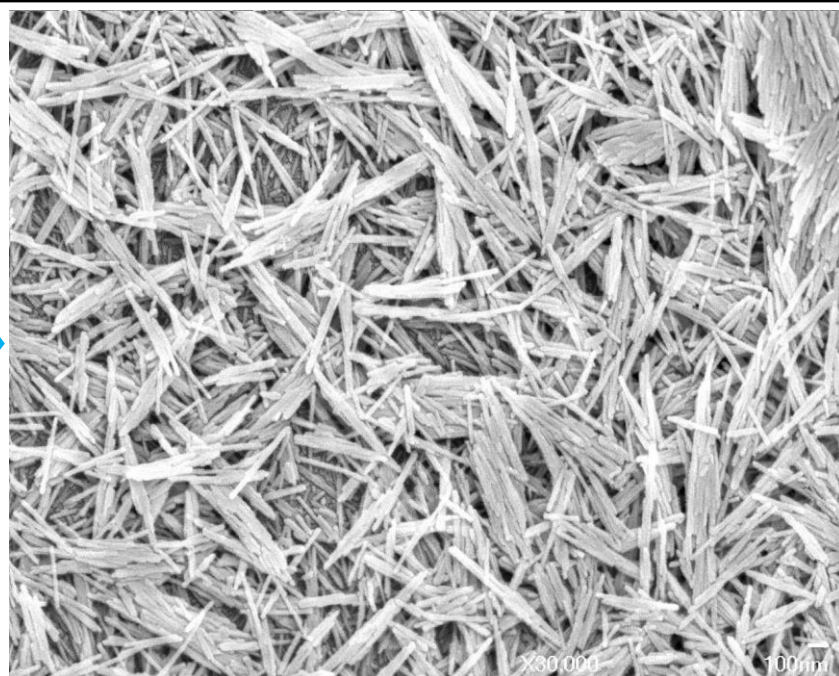
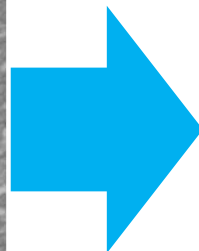
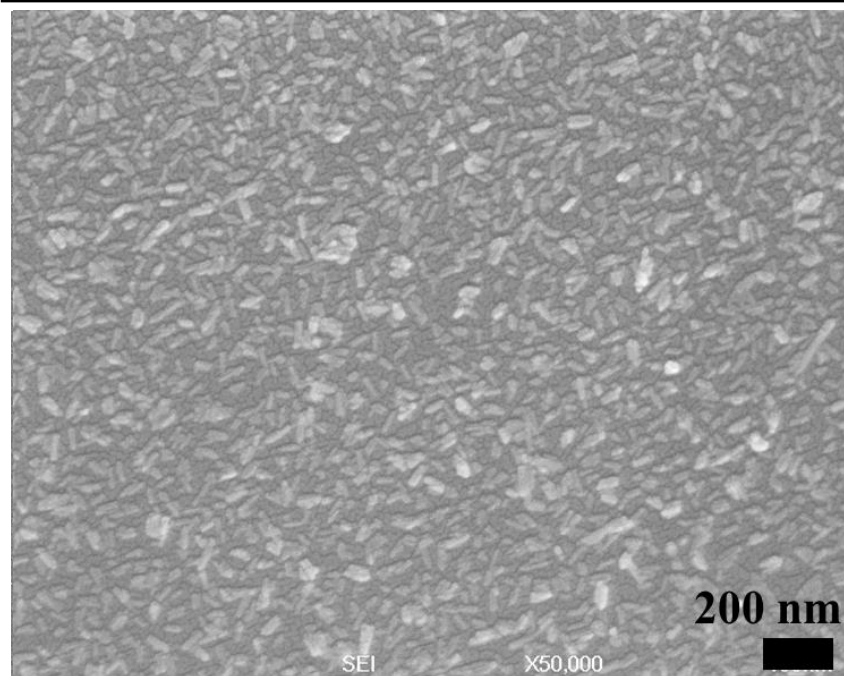


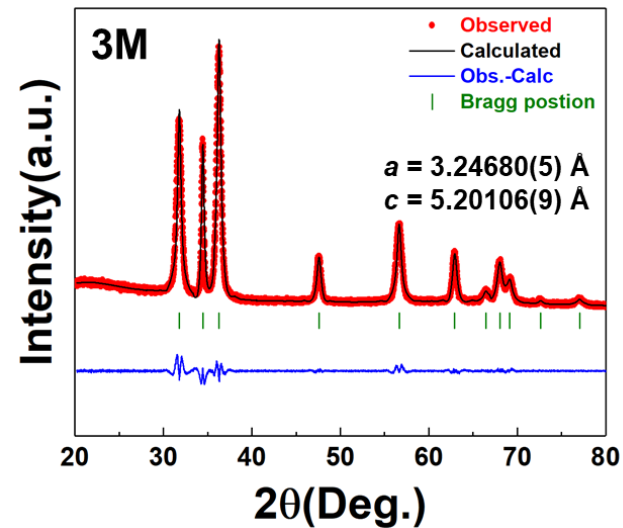
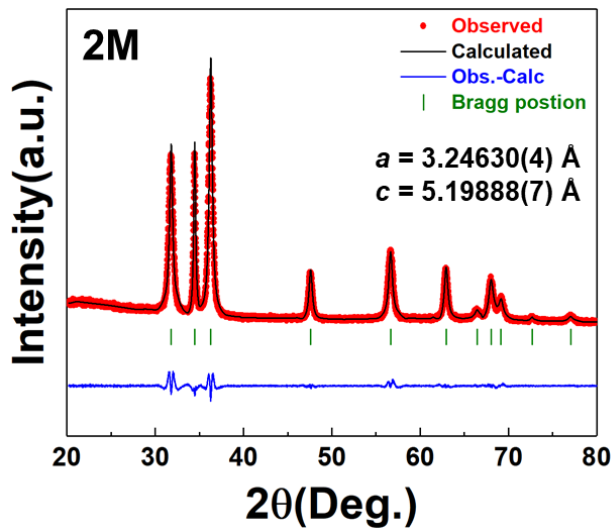
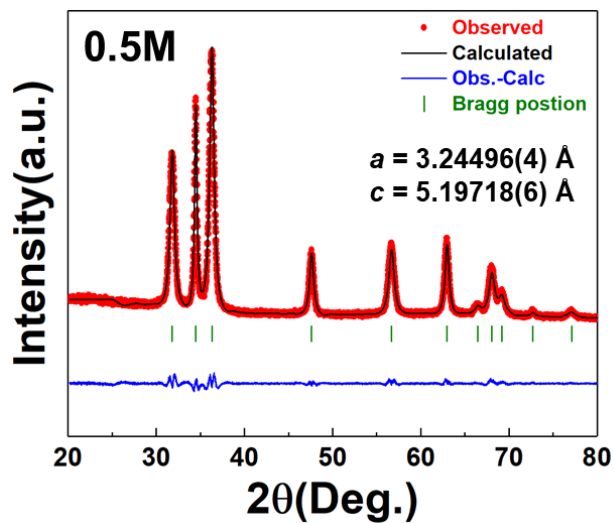
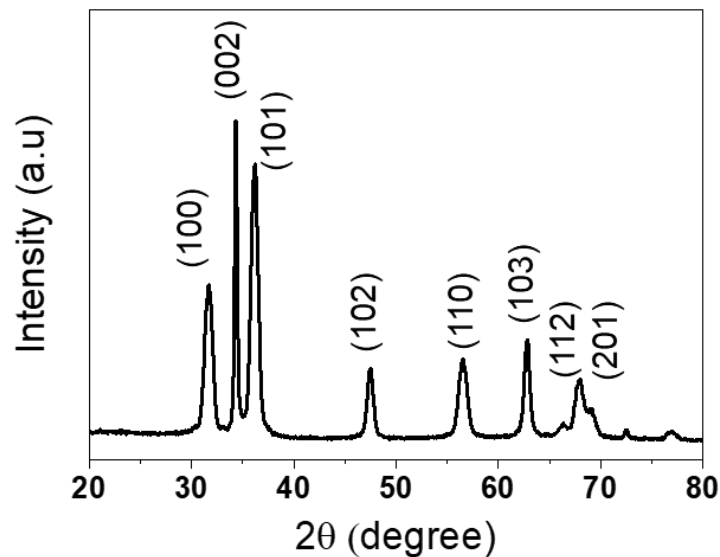
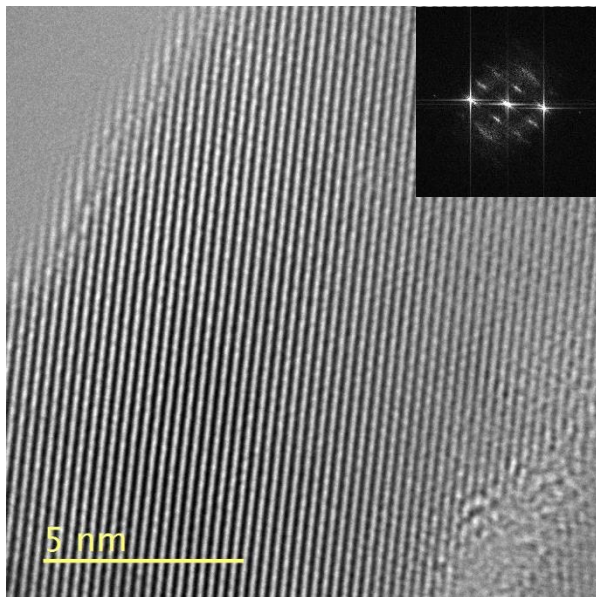
Low
concentration



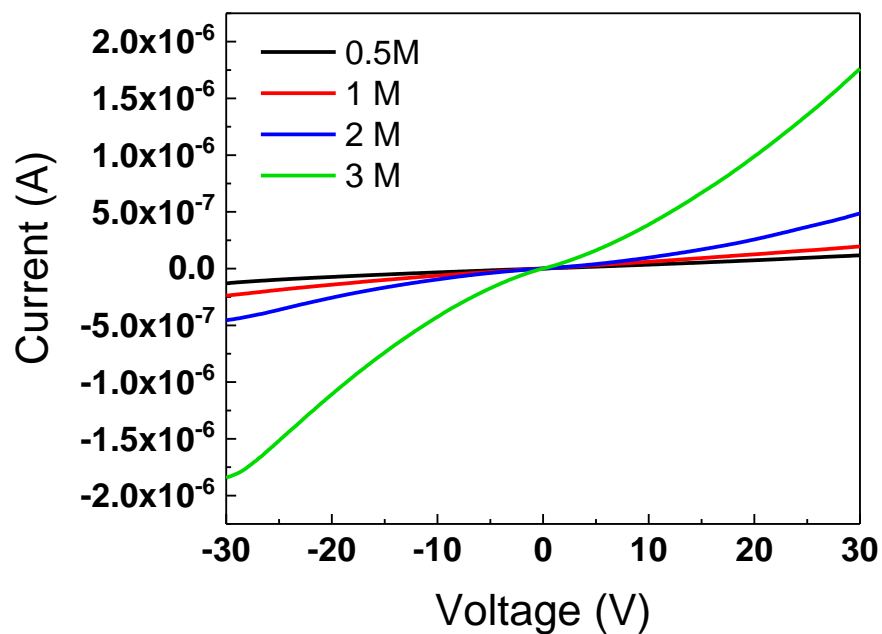
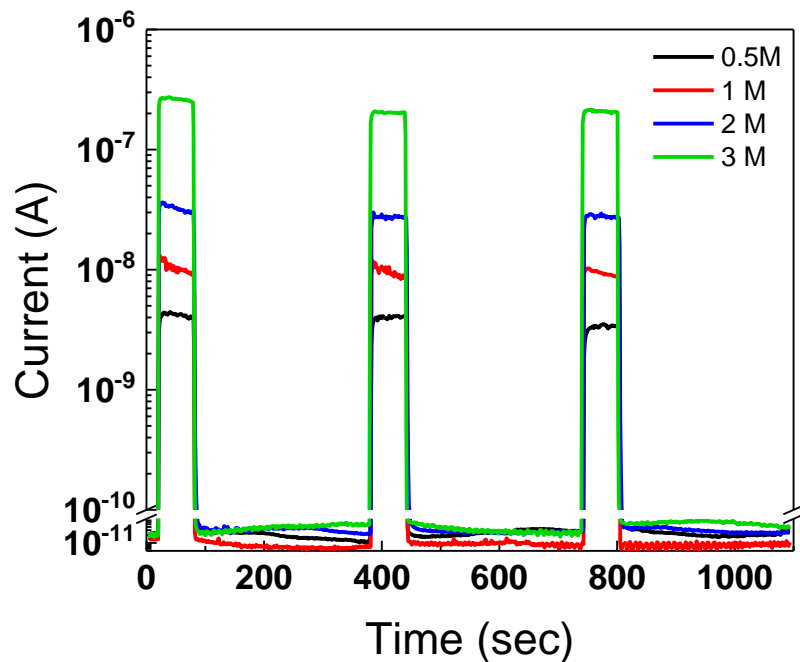
Growth Step

Different
concentration



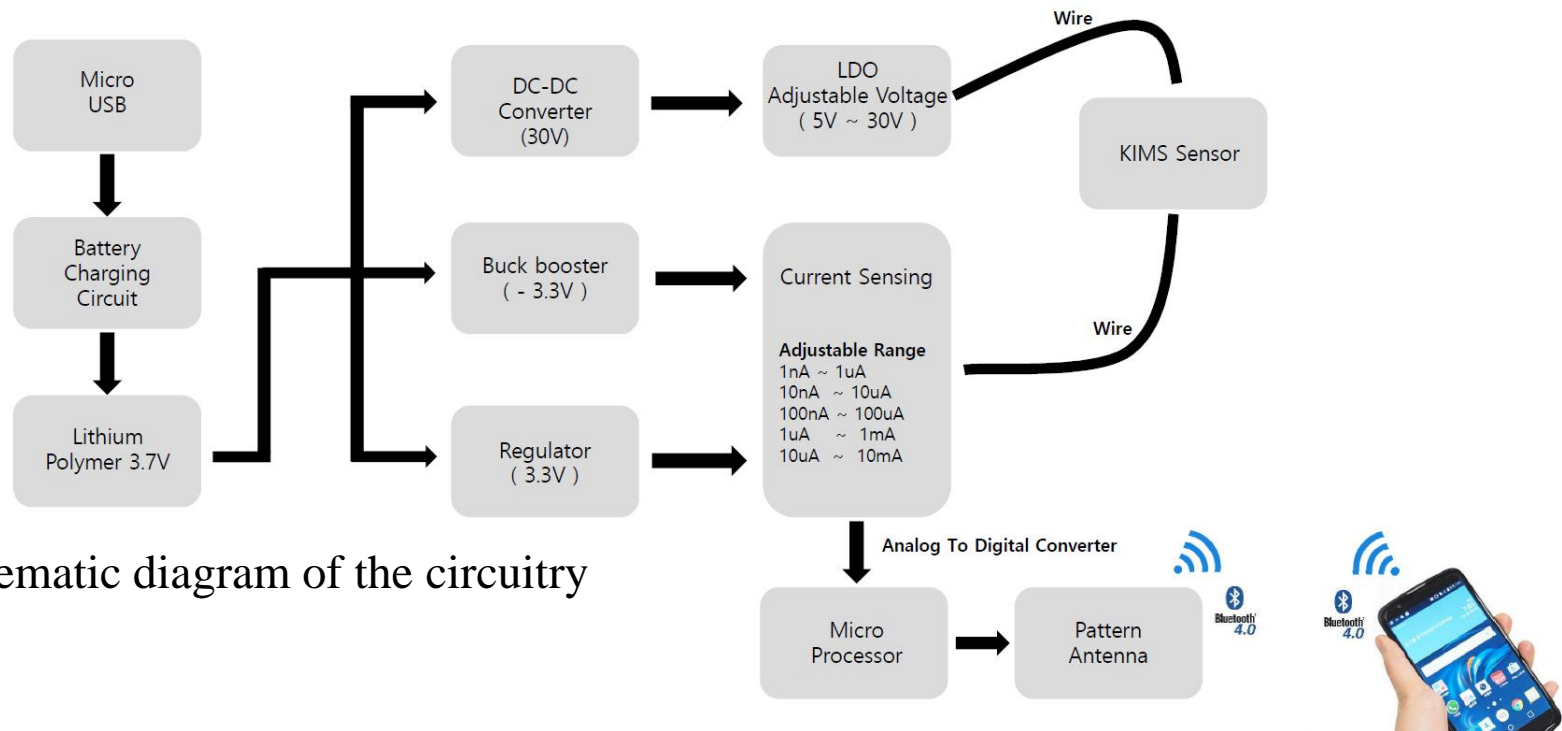


TEM and XRD pattern of ZnO nanomaterials with different aspect ratio

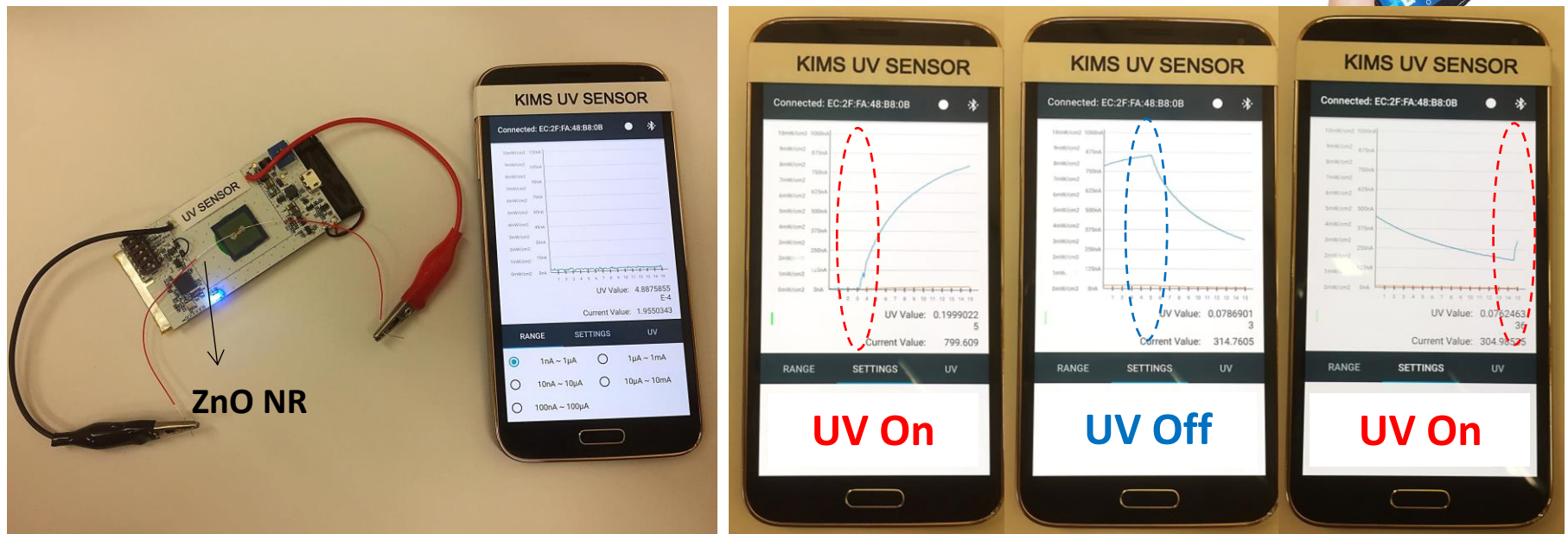


Growth reaction precursor concentration	Aspect ratio (average/maximum)	I_{UV} / I_{dark}	Response time (s)	Reset time (s)	Responsivity (A/W)
0.5 M	-	2.62×10^2	5.15	1.10	9.46×10^{-3}
1 M	4.5 / 5.5	1.08×10^3	2.61	1.61	2.75×10^{-2}
2 M	13.5 / 20.1	1.35×10^3	3.00	1.50	7.58×10^{-2}
3 M	18.6 / 27.3	1.09×10^4	3.10	1.25	5.55×10^{-1}

Optoelectric properties of ZnO NRs under repeated UV irradiation on and off



A schematic diagram of the circuitry



Photographic images of the Bluetooth connected ZnO NRs UV sensor module

Conclusion

- Aspect ratio controlled ZnO nanorods were successfully synthesized via two step processes.
- The ZnO NR morphology and crystal structure were analyzed. The original wurtzite structure of ZnO was observed.
- As the length of ZnO nanorods was longer, UV responsivity is 58.5 times higher.
- The wireless ZnO NR UV sensor platform was operated successfully and the sensing results were observed on a smartphone screen connected through Bluetooth.

Future work

- Fiber type or flexible sensors with high sensitivity based on metal oxide materials.
- Composites sensor will be prepared for wearable devices.

