Fabrication of IoT Sensors: a Wearable UV Radiation Detection Device

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Abstract

- A compact and wearable device is designed and developed to measure real-time intensity of the UV radiation.
- The flexible UV sensor was printed on a polyethylene terephthalate (PET) substrate using a low-cost screen-printing technology and integrated on the developed device
- The developed device shows the response to UV radiation as the intensity changes.
- The Arduino reads sensor data and an RGB LED is programmed to flash red when UV intensity is high and green when it is low

Background

- Compact and wearable devices are portable, hands-free, and consume less energy.
- Flexible sensors function even with applied mechanical pressure and can be used for a wearable application.
- Real-time measurement of UV intensity informs users when to limit their UV exposure.

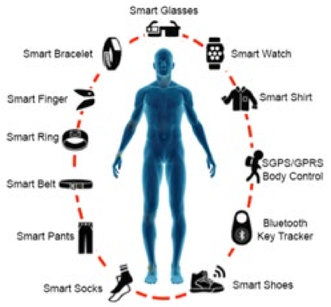

Fig 1. Wearable devices currently on the market [1]

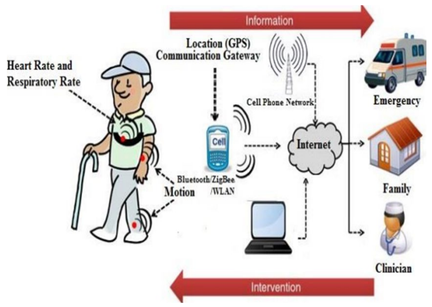

Fig 2. Schematic representation of the use of wireless wearable sensors for IOT [2]

Working Principle of UV Sensor

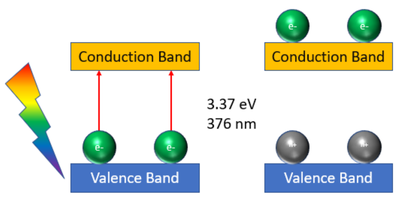

Fig 3. Schematic demonstrating working principle of UV sensor

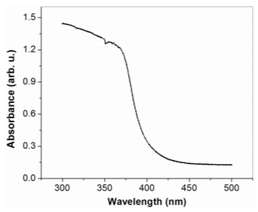

Fig. 4. UV-vis Absorbance spectrum of ZnO [3]

- Zinc Oxide semiconductor has a band gap energy of 3.37 eV or 376 nm (UV light)

Experimental Process

Sensor Fabrication

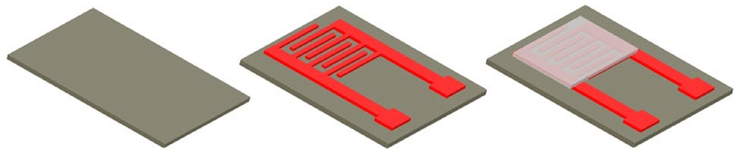

Fig 5. Sensor fabrication using screen-printing technique [4]

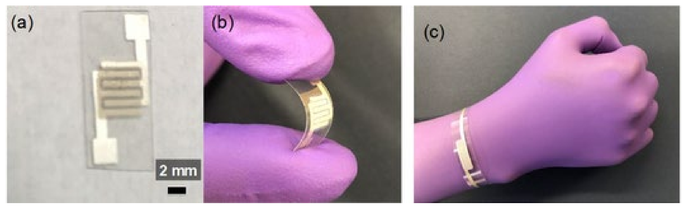

Fig 6. Photograph of (a) Fabricated sensor (b-c) showing flexibility of the sensor [4]

Device Testing Phase

- UV flashlight emitting a 365nm wavelength is flashed on sensor
- Arduino is programmed to flash red LED if UV radiation is higher than the safe limit

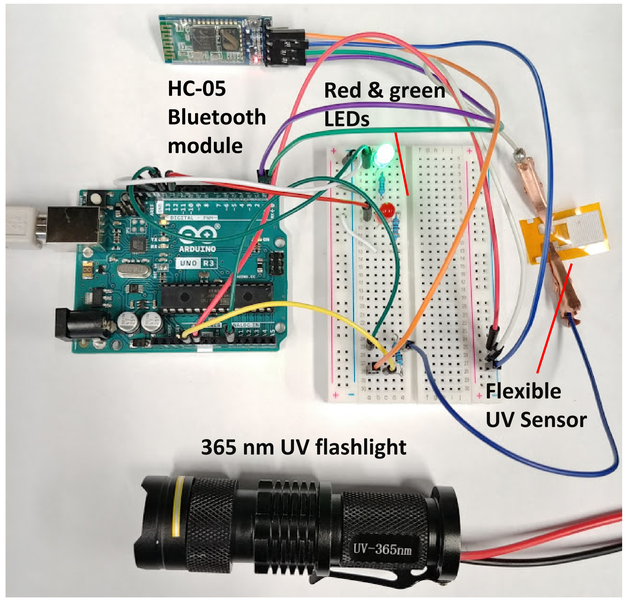

Fig 7. Setup in testing phase.

Results

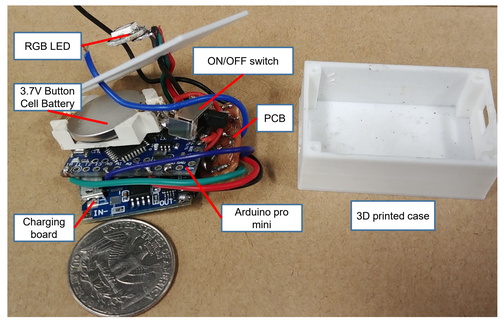

Fig 8. Compact device design and 3D printed case

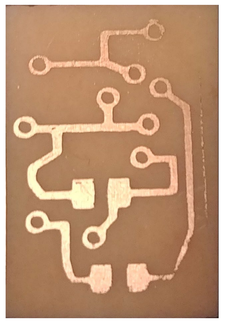

Fig 9. Printed Circuit board for the UV wearable

- A 15 mm x 20 mm printed circuit board was created in circuit simulation software, and the RGB LED, UV sensor, and chip resistors were soldered to the PCB.
- The dimensions of the 3D printed case for the device is 45 mm x 28 mm x 20 mm.

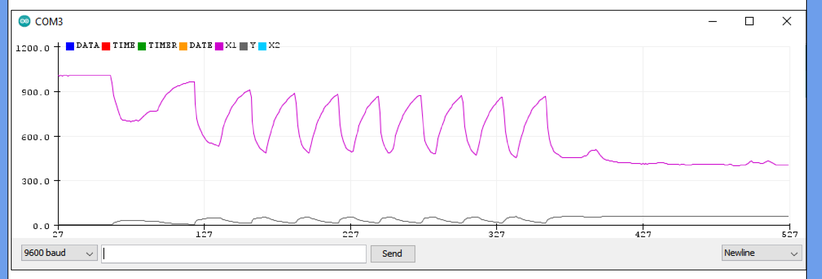

Fig 10. Sensor response towards cyclic UV illumination

- Resistance decreases as UV intensity increases.

Conclusion

- The sensor reports lower resistance values when exposed to UVR.
- WS2812B LED flashed red or green according to UV intensity.
- The device is more compact after using smaller components (Arduino pro mini, chip resistors, RGB LED) permitting the user to wear it on their wrist and view UV exposure in real-time.

Acknowledgements

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[1]Rodrigues, J.J., Segundo, D.B.D.R., Junqueira, H.A., Sabino, M.H., Prince, R.M., Al-Muhtadi, J. and De Albuquerque, V.H.C., 2018. Enabling technologies for the internet of health things. *Ieee Access*, *6*, pp.13129-13141.

[2] Nag, A., Mukhopadhyay, S.C. and Kosel, J., 2017. Wearable flexible sensors: A review. *IEEE Sensors Journal*, *17*(13), pp.3949-3960.

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[4] Pathak, P., Park, S. and Cho, H.J., 2020. A Carbon Nanotube–Metal Oxide Hybrid Material for Visible-Blind Flexible UV-Sensor. *Micromachines*, *11*(4), p.368.