Non-Invasive, Low-Cost Detection of Chronic Obstructive Pulmonary Disease (COPD) via Smartphone Breath Analysis

Hussain, Hiba (School: Greenwich High School)

Chronic Obstructive Pulmonary disease (COPD) is expected to become the third largest killer worldwide by 2030. Current diagnosis mechanisms are time-consuming and costly, highlighting the need for a more accessible and rapid diagnosis so that the disease can be treated at its earliest stage. In this research, a rapid and simple smartphone-based detection of COPD was created. Single-walled carbon nanotubes (SWCNTs) were combined 2-hydroxy-1,1,1,3,3,3-hexafluoropropyl)-1-naphthol (HFIPN) in a 2:1 mass ratio, to create a COPD-breath gas specific PENCIL powder. When integrated into a Texas Instruments NFC Tag, and exposed to COPD breath gases isoprene, octadecane, hexanal, and undecane, conformational change in the PENCIL-HFPN selector was realized by an increase in the material's resistivity. Exposure of the PENCIL-on-NFC tag to 1ppb and 1 ppm COPD breath gases caused an increase in PENCIL resistance from 13-13.7kΩ and 12.7-27kΩ, respectively. Change in PENCIL-on-NFC tag resistivity produces changes in current usage drawn from a Smartphone, when read by the device, and acts as the basis for COPD detection. After 1 minute of exposure to typical 1ppb concentration of COPD breath gases for an afflicted patient, Smartphone read of the PENCIL-on-NFC tag drew only 1.5mA of current, which is 3.5mA less than current used under normal, ambient conditions. Increase in PENCIL resistance, and subsequent Smartphone current reduction was found to be COPD gas specific and was used to train a new Smartphone application to provide a 4-minute diagnosis for COPD, based on calibration of the circuit's current usage, and its effect on the phone's battery usage.

Awards Won:

Third Award of $1,000