Chemical Engineering Doctoral Defense

Sensors and their applications for connected health and environment

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abstract

Connected health is an emerging field of science and medicine that enables the collection and integration of personal biometrics and environment, contributing to more precise and accurate assessment of the person's state. It has been proven to help to establish wellbeing as well as prevent, diagnose, and determine the prognosis of chronic diseases. The development of sensing devices for connected health is challenging because devices used in the field of medicine need to meet not only selectivity and sensitivity of detection, but also robustness and performance under hash usage conditions, typically by non-experts in analysis. In this work, the properties and fabrication process of sensors built for sensing devices capable of detection of a biomarker as well as pollutant levels in the environment are discussed. These sensing devices have been developed and perfected with the aim of overcoming the aforementioned challenges and contributing to the evolving connected health field. In the first part of this work, a wireless, solid-state, portable, and continuous ammonia (NH_3) gas sensing device is introduced. This device determines the concentration of NH_3 contained in a biological sample within five seconds and can wirelessly transmit data to other Bluetooth enabled devices. In this second part of the work, the use of a thermal-based flow meter to assess exhalation rate is evaluated. For this purpose, a mobile device named here mobile indirect calorimeter (MIC) was designed and used to measure resting metabolic rate (RMR) from subjects, which relies on the measure of O_2 consumption rate (VO_2) and CO_2 generation rate (VCO_2), and compared to a practical reference method in hospital. In the third part of the work, the sensing selectivity, stability and sensitivity of an aged molecularly imprinted polymer (MIP) selective to the adsorption of hydrocarbons were studied. The optimized material was integrated in tuning fork sensors to detect environmental hydrocarbons, and demonstrated the needed stability for field testing. Finally, the hydrocarbon sensing device was used in conjunction with a MIC to explore potential connections between hydrocarbon exposure level and resting metabolic rate of individuals. Both the hydrocarbon sensing device and the metabolic rate device were under field testing. The correlation between the hydrocarbons and the resting metabolic rate were investigated.

September 17, 2018; 8:00 AM; ECG 218