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Heater and Substrate Profile Optimization for Low Power Portable Breathalyzer to Diagnose Diabetes Mellitus

Authors : Ramji Kalidoss, Snekhalatha Umapathy, V. Dhinakaran, J. M. Mathana

Abstract : Chemi-resistive sensors used in breathalyzers have become a hotspot between the international breath research communities. These sensors exhibit a significant change in its resistance depending on the temperature it gets heated thus demanding high power leading to non-portable instrumentation. In this work, numerical simulation to identify the suitable combination of substrate and heater profile using COMSOL multiphysics was studied. Ni-Cr and Pt-100 joule resistive heater with various profiles were studied beneath the square and circular alumina substrates. The temperature distribution was uniform throughout the square substrate with the meander shaped pt100 heater with 48 mW power consumption for 200 oC. Moreover, this heater profile induced minimal stress on the substrate with 0.5 mm thick. A novel Graphene based ternary metal oxide nanocomposite (GO/SnO2/TiO2) was coated on the optimized substrate and heater to elucidate the response of diabetes biomarker (acetone). The sensor exhibited superior gas sensing performance towards acetone in the exhaled breath concentration range for diabetes (0.25 – 3 ppm). These results indicated the importance of substrate and heater properties along with sensing material for low power portable breathalyzers.

Keywords : Breath Analysis, Chemical Sensors, Diabetes Mellitus, Graphene Nanocomposites, Heater, Substrate
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