Diagnostic Biosensing: a Multimodal Breath Sensor

Breath ammonia is an important biomarker for patients with chronic kidney disease (CKD) and chronic liver disease (CLD). However, existing breath ammonia sensors fail to compensate for the impact of breath humidity and complex breathing motions associated with a human breath sample. Here, we present a multimodal breath sensing system that integrates an ammonia sensor based on a thermally cleaved conjugated polymer, a humidity sensor based on a reduced graphene oxide (rGO) polymer, and a breath dynamics sensor based on a 3D folded strain-responsive mesostructure. The miniaturized construction and module-based configuration offer flexible integration with a broad range of masks and allow Bluetooth compatibility for rapid, wireless transmission of physiologically relevant sensing information. The mask-insert design is suitable for diagnosis and monitoring of CKD and CLD through facile data analysis and sharing with clinical professionals. Experimental results present capabilities of the system in continuously detecting diagnostic ranges of breath ammonia under real, humid breath conditions with sufficient sensing accuracy and selectivity over three weeks. The on-body test highlights the operational simplicity and practicality of the system for noninvasively tracing essential biomarkers, suggesting its promising potential to capture early warning signs of organ dysfunctions for patients with CKD and CLD.