Graphene Field-Effect Transistors for the On-Site Wastewater Monitoring of SARS-CoV-2

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Wastewater monitoring, as deployed by the National Wastewater Surveillance System, serves as both an early warning tool and a real-time indicator of the prevalence of SARS-CoV-2 in communities. Samples are collected from sewersheds across the U.S. and transported to environmental or public health laboratories for testing. To streamline this workflow, we present a graphene-based biosensing platform for the efficient, on-site testing of SARS-CoV-2 in wastewater.

The sensor comprises of an array of 52 graphene field effect transistors (GFETs) on a small 2 x 2.5 cm silicon chip, working simultaneously to achieve enhanced sensitivity and fast detection times. Scalable and reproducible fabrication of GFETs is achieved through the integration of optimized photolithographic, deposition and etch processes. We demonstrate a label- and amplification-free detection of SARS-CoV-2 RNA in RNase free water, achieving a significantly low limit of detection of 0.1 aM (~ 60 viral RNA copies/ml), with high specificity, and rapid detection time of 60 minutes. These results position us well to extend SARS-CoV-2 RNA detection to increasingly complex sample matrices, such as tap water and wastewater. Furthermore, the graphene sensing platform is compatible with conventionally used and commercially available microelectronics, supporting its potential as a portable, on-site wastewater monitoring tool.

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