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Advanced Solid State Nanopores Architectures: From Early Cancer Detection to Nano-electrochemistry[1]

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Solid-state nanopores (ssNPs) are potentially low-cost and highly scalable technologies for rapid and reliable se-quencing of the human diploid genome for under $1,000. The ssNPs detect ionic current changes while molecules translocate through the pore. Several key challenges must be overcome in order for ssNPs to become ubiquitous in the fields of medical diagnostics and personalized healthcare. One major challenge is to reduce the speed at which DNA translocates through the nanopore from microseconds to milliseconds per nucleotide, enabling reliable identification of single nucleotides. The other major challenge is to improve the sensitivity of the approach requiring new sensing modalities and novel device architectures. In this paper, we review our recent efforts to (i) develop ssNPs for early cancer detection, (ii) to embed graphene electrodes in dielectric nanolaminates to form 3 and 4 terminal nanopore devices, and (iii) we demonstrate a nanopore based structure consisting of stacked graphene and Al_2O_3 dielectric layers to study electrochemical activity at graphene edges. The electrochemical signal corresponding to the atomically thin graphene layer could also provide a pathway to DNA sequencing.

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