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CMOS Nanowire Biosensor Systems

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Nanoscale electronic devices have the potential to achieve exquisite sensitivity as sensors for the direct detection of molecular interactions, thereby decreasing diagnostics costs and enabling previously impossible sensing in disparate field environments. Semiconducting nanowire-field effect transistors (NW-FETs) hold particular promise, though contemporary NW approaches are inadequate for realistic applications. We present here a number of top-down fabricated nanowire approaches that are compatible with complementary metal-oxide-semiconductor (CMOS) technology that has not only achieved unprecedented sensitivity, but simultaneously facilitates system-scale integration of nanosensors. These approaches enable a wide range of label-free biochemical and macromolecule sensing applications, such as specific protein and complementary DNA recognition assays, and specific macromolecule interactions at <femtomolar concentrations. An important achievement is the introduction of real-time, unlabeled detection capability which allows for fundamental studies of cellular activation, cell type discrimination through the monitoring of live, stimulus-induced cellular response, and live cell peptide-specific immunoresponse. A critical limitation of nanowire sensors is the Debye screening issue which has to date prevented their use in clinical applications and physiologically relevant solutions. We will present an approach that solves this longstanding problem, and demonstrate the detection at clinically important concentrations of cancer biomarkers from whole blood samples.