Grand Challenges in Application of Nano-Bio-Sensors For Real Time And On Site Environmental Monitoring

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The health risks and harmful environmental impacts associated with the ever-increasing number of emerging contaminants in water necessitate a breakthrough in water quality monitoring technology to detect and evaluate harmful effects of the plethora of contaminants in waters. Current water quality monitoring methods, which rely mostly on laborious and time-consuming chemical/biological analysis, only can tell yesterday's story due to the delayed results and therefore can not provide real time information that is needed for pollution source identification and elimination.

The tremendous advancement in the biotechnology/biosensing field and in nanotechnology development in recent years has broken new ground for environmental sensing and analysis. The unique properties and behavior of nanomaterial make it idea for nao-biosensor development with remarkable advantages including extremely high sensitivity (detection limit down to tens of molecules level), high selectivity (versatile fictio
nalization with various biological recognition molecules/elements) and possibility for assembling high-density nanoarray to miniature the sensor for on-site applications. Among the various forms of nanostructures that have been explored for sensor development, carbon nanotube field effect transistors (CTNs-FETs) shows great potential for environmental monitoring. Our goal is to integrate single-walled CTNs with various recognition elements onto CMOS integrated circuit to develop miniature nanosensor chip for real time and on site monitoring of water contaminants (Figure). Electrical detection allows for simple and inexpensive instrumentation, which improves the portability of these types of devices. Specific recognition molecules (e.g. antigen, enzyme, DNA) can be attached to the CTNs to target various analytes based on the different molecular recognition interactions, which allow for the development of nanosensors that are highly selective and sensitive. The main challenges include:

develop specific bio-recognition elements for targeting various pollutants, compatibility of reaction/deactivation conditions among different analytes and integration of key components including sample reservoir, sample feeding/contact condition control and signal processing and transmission.