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Developing a Label-Free, Redox Biosensor for Detection of Early Stage Cancer Biomarkers

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Cancer is a leading cause of death in the United States, in part, because the disease is usually diagnosed after it has metastasized to distant tissues and organs, at which time treatment options are limited and usually ineffective. Technologies to detect cancer at an early stage, when it is curable by current therapeutics, would provide significant benefit to cancer disease patients. Clinical measurement of biomarkers offers the promise of a noninvasive and cost effective screening for early detection of cancer. We have developed a novel 3-dimensional "nanocavity" array for the detection of human cancer biomarkers in serum and other fluids. This all-electronic diagnostic sensor is based on a nanoscale coaxial array architecture (Rizal, et al. 2013) that we have modified to enable molecular-level detection and identification. Each individual sensor in the array is a vertically-oriented coaxial capacitor, whose electrical capacitance and dielectric impedance are measurably changed when target molecules enter the coax annulus. We are designing a nanocoaxial biosensor based on electronic response to antibody recognition of a specific cancer biomarker (e.g. CA-125 for early-stage ovarian cancer) on biofunctionalized metals surfaces within the nanocoax structure, thereby providing an all-electronic, ambient temperature, rapid-response, label-free redox biosensor. Our results demonstrate the feasibility of using this array as an ultrasensitive device to detect a wide range of proteins of interest, including disease biomarkers.

B. Rizal, B. Ye, P. Dhakal, T. C. Chiles, S. Shepard, G. McMahon, M. J. Burns, M. J. Naughton, Nano-optics for enhancing light-matter interactions on a molecular scale : plasmonics, photonic materials and sub-wavelength resolution, B. Di Bartolo, J. Collins, L. Silvestri (eds), Springer, Dordrecht 2013, p. 359.

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