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Applications of nanosensors to glycoprofiling

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It is widely recognized that an array of addressable sensors can be multiplexed for the label-free detection of a library of analytes. However, such arrays have useful properties that emerge from the ensemble. As examples, we show that an array of near-infrared fluorescent single-walled carbon nanotube (SWNTs) sensors can estimate the mean and variance of the observed dissociation constant (KD), using three different examples of binding IgG with Protein A as the recognition site, including polyclonal human IgG, murine IgG and human IgG from CHO cells. In addition, we show that the observed dissociation constant is concentration-dependent, indicating multivalent interactions between the two binding partners. A bivalent binding mechanism is able to describe the concentration dependence of the effective dissociation constant, KD,eff, which varies from 100 pM to 1 μM for human IgG concentrations from 1 ng mL^{-1} to 100 μ g mL^{-1}, respectively. We also demonstrate that an array of nanosensors can uniquely monitor weakly affined analyte interactions by monitoring the metabolically induced hypermannosylation of human IgG from CHO using PSA-lectin conjugated sensor arrays. In addition to our glycan profiling work using lectin-functionalized nanosensors, we have designed synthetic molecular recognition sites for carbohydrates using Corona Phase Molecular Recognition; a detection technology invented by our lab. Herein we synthesized 14 variants of well-defined water-soluble boronic acid copolymers through RAFT polymerization and created 14 distinct corona phases by adsorbing them onto the nanotube surface. We screened them against a panel of saccharides and sugar alcohols, revealing a corona phase that recognizes specific saccharides with high selectivity. In response to D-Arabinose binding, SWNT fluorescence decreases by >60% at saturation, while showing less than 20% response to all other aldopentoses including L-Arabinose. Binding selectivity was tuned by varying the location of boronic acid from para to meta and was also observed through cryogenic-TEM.

Biography

Daniel Salem has received his BS in Chemical Engineering from the University at Buffalo and a Master's degree in Chemical Engineering Practice from the Massachusetts Institute of Technology, USA. He is currently a National Science Foundation Graduate Research Fellow under the guidance of Professor Michael Strano in the Department of Chemical Engineering at MIT. His research involves the design of carbon nanotube-based optical sensors for biopharmaceutical characterization, diagnostics and food and water-borne contaminant detection.

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