Molecular Recognition Using Corona Phase Complexes Made of Synthetic Polymers Adsorbed on Carbon Nanotubes

Molecular recognition is central to the design of therapeutics, chemical catalysis and sensor platforms, with the most common mechanisms involving biological structures such as antibodies[1] and aptamers[2,3]. The key to this molecular recognition is a folded and constrained heteropolymer pinned, via intra-molecular forces, into a unique three-dimensional orientation that creates a binding pocket or interface to recognize a specific molecule. An alternate approach to constraining a polymer in three-dimensional space involves adsorbing it onto a cylindrical nanotube surface[4-7]. To date, however, the molecular recognition potential of these structured, nanotube-associated complexes has been unexplored. In this work, we demonstrate three distinct examples in which synthetic polymers enable unique and highly selective molecular recognition once adsorbed onto a single-walled carbon nanotube (SWCNT) surface. The phenomenon is shown to be generic, with new recognition complexes demonstrated for riboflavin, L-thyroxine, and estradiol, predicted using a 2D thermodynamic model of surface interactions. The dissociation constants are continuously tunable by perturbing the chemical structure of the heteropolymer. We study the molecular recognition process in real-time with single-molecule imaging of our nanosensor platform. The complexes can be used as new types of sensors based on modulation of SWCNT photoemission, as demonstrated using a complex for real time spatio-temporal detection of riboflavin in murine macrophages.

References

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