

Photoluminescent Response of Poly(3-methylthiophene)-DNA Single Nanowire Correlating to Nucleotide-Mismatch Locus in DNA–DNA Hybridization

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π -Conjugated polymers have become qualified candidates for biosensing owing to their unique optoelectronic properties and excellent biocompatibility. In this contribution, nucleotide mismatches in DNA hybridization, being variable in position, are reflected in a stark manner by poly(3-methylthiophene) (P3MT) nanowires (NWs), in which probe DNA sequence is properly functionalized. Selected as the systematic investigation are complementary target DNA (tDNA), random sequence DNA, and three kinds of 1-mer mismatched tDNAs with different mismatch loci away from the NW's surface. Nanoscale optical observation of the single P3MT NWs in solid states reveals that the more distant the mismatch position is from the surface, the higher the photoluminescence (PL) occurs, while the complementary sequence yields the highest but the random one remains the lowest. Hence, the PL intensity increases with the relative length of the DNA–DNA hybridization from the surface. These results deliver a new basis that π -conjugated polymers can be potentially applicable to detailed nucleotide analyses as in single nucleotide polymorphism.

Accurate inspections in problems of the biological system at the early stages have the most significant impact on the quality of life of the host body.^[1,2] The technique of identifying these problems in an easy and simple way, rather than complicated tools, will greatly improve our benefits.^[3,4] The success of biological

examination depends on the accuracy of diagnosis, detection sensitivity, signal response time, and accessibility of gene analysis tools.^[5–10]

π -Conjugated polymers are emerging as a promising material for biological recognitions due to their better compatibility with biological materials and their novel optical and electrical signal conversion characteristics.^[11–16] π -Conjugated polymer-based biological sensors show enhanced detection capability because a local single change can affect the properties of the whole system.^[17,18] However, the biological recognition research on solution basis requires a large amount of target materials and has shortcomings in the study of selectivity and sensitivity, which are limited to practical applications.^[19–21] The use of light-emitting organic nanomaterials is of great advantage in studying interaction with biomaterials.^[22–24] Low-dimensional,

organic-based nanostructures in solid state have shown promising performances in highly sensitive and specific nanoscale sensing owing to their remarkable response capability.^[25,26] Biological materials can be readily identified through the variation of light-emitting characteristics of polymer nanostructures when appropriate receptors are linked to their active surfaces. For instance, the luminescence intensity and color of the light-emitting polymer nanostructures can be changed upon specific biological interactions.

We previously reported the effective optical assays on DNA hybridization and protein binding by using doped poly(3-methylthiophene) (P3MT) nanowires (NWs) in solid states.^[27,28] The P3MT NWs can be a promising system to study precise DNA–DNA interactions depending on variations with photoluminescence (PL) property through the formation of doping-induced bipolaron states.^[27] The light emission characteristics of P3MT NWs upon recognition of target DNA (tDNA) molecules were monitored using a high-resolution laser confocal microscope (LCM) PL experiments. The luminescence intensity of the P3MT NWs was dramatically enhanced by the DNA hybridization. This PL enhancement is considered an increase in exciton diffusion length induced by the relatively well-ordered structure of the P3MT NWs upon recognition of the target.^[28]

Herein, we experimentally demonstrate the response to imperfect DNA hybridization events by luminescent P3MT

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