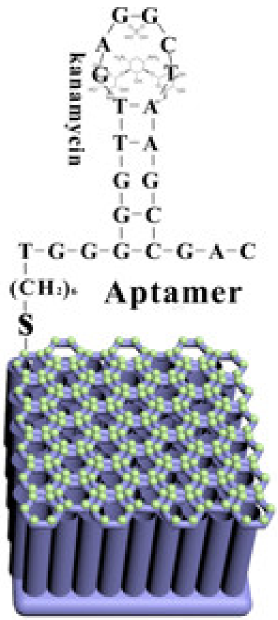
The new photoelectrochemical aptamer biosensor



The photoelectrochemical (PEC) biosensing is a new and promising analytical technique to detect biomolecules with high sensitivity. As core unit of PEC biosensor, photoelectrode materials play an irreplaceable role for its detecting performance. Among them, titanium dioxide (TiO_2) is the most popular material due to its excellent photoelectric properties, low cost and favorable biocompatibility. However, its fatal disadvantage is the strong absorption in the UV region, while almost no absorption in the visible region. So many strategies have been employed to expend the optical absorption of TiO_2-based photoelectrodes, such as composing with small bandgap semiconductors, modifying with noble metal nanoparticles (NPs), doping with hetero- or homo-elements.

Our group has been working on the titanium dioxide material and developed a sensitive and selective photoelectrochemical aptamer biosensor based on Au anoparticles functionalized self-doped TiO_2 nanotube arrays (aptamer-Au/SD-TiO_2 NTs). The TiO_2 NTs were fabricated in a facile two-step anodization process. Then electrochemical reduction was conducted in the supporting electrolyte to induce the self-doping center of Ti^{3+} into the TiO_2 NTs. Compared with hetero-doping, self-doping using the homo-species surface defect engineering strategy is a more rational option to realize the enhancement of PEC performance. Then, Au NPs were decorated on the self-doped TiO_2 NTs in a photocatalytic reduction process to form Au/SD-TiO_2 NTs. The Au NPs owned double-functions, one was the enhancement of the PEC performance in the visible light region as a sensitizer due to their surface plasmon resonance (SPR) activity, and another one was immobilizing aptamers on the Au NPs surface. Aptamers, single-stranded oligonucleotides with specific sequences, have an effective recognition unit with the ability to rapidly and accurately recognize their cognate targets. Herein, in this work, a new PEC aptasensor of aptamer-Au/SD-TiO_2 NTs was fabricated to detect kanamycin. It was found that the detection limit can be low to 0.1 nM, and the PEC aptasensor possessed a very favorable selectivity toward kanamycin detection.

The new PEC aptasensor paved a new avenue not only for designing of sensitive PEC sensors but also exploiting its PEC applications for solar energy conversion. We believed that the integration of PEC detection with aptamer recognition strategy opened up a new detection approach, shed light on the further fusing of PEC technique with other analytical methods.

Publication

Photoelectrochemical aptasensor for the sensitive and selective detection of kanamycin based on Au nanoparticle functionalized self-doped TiO2 nanotube arrays.
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