chemosensors

Editorial

Chemical Reagents for Sensor Design and Development

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1. Introduction

The combination of selective chemical reagents with sensitive physical transducers can often bring about new sensor designs and novel device construction that are capable of quantitative analysis of various sample matrices to determine important ionic or molecular analytes [1]. A simple squaramide chemodosimeter for Cu^{2+} is based on selective chelation that induces the formation of a highly colored zwitterionic radical for visual and selective sensing of Cu^{2+} at neutral pH [2]. A sophisticated NO_3^- sensor is built on the field-effect transistor device with reduced graphene oxide nanosheets that uses benzyl triethylammonium chloride as a capture probe [3]. Optical sensors based on different detection principles for monitoring water quality parameters usually rely on the addition of reagents [4]. Efficient design of new chemical sensors often requires a comprehension of all reagents that are crucial to successful development and validation. Functional reagents may be chromogenic, derivatizing, fluorogenic, imaging, reactive, redox, and even specific in their chemical functionality. A critical choice of the most appropriate reagent can help the manufacturing engineer or research scientist go a long way towards cost-effective production and valid applications. Suitable reagents may span across biochemical, inorganic, organic, and polymeric substances that are either commercially available for immediate use or synthetically facile to prepare in the lab. Proper use of each reagent may be governed by pH, temperature, solvent, redox, enzyme, light, ultrasound, magnetic field, and safety concerns. Both logical deduction and creative thinking can bring about novelty in a unique way that reagents may work synergistically towards a target analyte.

2. The Special Issue

This special issue focuses on the latest advances in chemical reagents that can facilitate the design and development of new sensors. Different kinds of ion complexing and molecular association agents may be presented together with their immobilization on a transducer surface. Surface modification can enhance the properties and characteristics of nanoparticles through functionalization with a natural biomolecule, polymer, dendron, small-molecule ligand or atomic layer, which enable them to play a new role in the field of nanoparticles-based biosensors/bioassays [5–7]. All crucial working parameters may be elaborated to achieve the best possible selectivity and highest practical sensitivity in chemical analysis. Practical applications and potential developments may be discussed to encourage further advance in this field of research.

For instance, 3-aminopropyl-triethoxysilane (APTES) is a versatile agent for modifying the surface chemistry of amorphous Si:H sensors for NaCl and bovine serum albumin [8]. APTES can assist the synthesis of silver nanoparticles using polyethyleneimine as a template for detecting Hg^{2+} by localized surface plasmon resonance light scattering technology [9]. A surface plasmon resonance-based human fetuin-A immunoassay involves the amino groups of APTES-functionalized Au chip that are cross-linked to the carboxyl groups of anti-HFA antibody using 1-ethyl-3-dimethylaminopropyl carbodiimide hydrochloride and sulfo-N-hydroxy succinimide [10]. Adsorption of APTES on ZnO nanoparticles augments its fluorescence due to the electron transfer; however, adsorption of APTES on Fe_2O_3 nanoparticles quenches its fluorescence due to the electron transfer [11,12]. Biotin-Fe_3O_4 nanoparticles can be applied in electrochemical immunosensor by selectively binding to streptavidin which is pre-linked to biotinylated antibody. The large surface area of nanoparticles and their repeating binding with streptavidin can amplify the signal to provide sensitive detection of the antibody [13]. A novel enzymatic glucose biosensor was fabricated using glucose oxidase immobilized into APTES-reduced graphene oxide [14]. A high-performance gas sensor can be designed using porous WO_3 nanotubes with a self-assembled monolayer of APTES that acts as an electron acceptor on the surface to provide specific interaction with NO_2 down to 10 ppb [15]. Gas microsensors based on WO_3 nanowires silanized with APTES are highly sensitive to ethanol at room temperature via photoactivation and show enhanced selectivity towards other volatile organic compounds including acetone and toluene [16]. Liquid silanization by APTES can be used as an intermediate step, followed by functionalization with molecules bearing ester end groups, to produce a sensor that is sensitive and selective to ammonia gas at room temperature [17]. Upon exposure to ammonia gas, the electrical conductance of ester modified SnO_2-APTES increases [18].

Another interesting reagent is *o*-phthaldialdehyde (OPA) that was employed to measure the free amino groups of peptides or proteins by reaction in the presence of 2-mercaptoethanol to generate a fluorescent product [19]. Different forms of homocysteine in urine or plasma can be determined by using OPA as a selective derivatizing agent [20,21]. A fluorescent SiO_2 particle-based sensor can successfully determines glutathione in dietary supplements with excellent recoveries [22]. An automated fluorescence sensor has recently been reported for the determination of hydrazine in drinking water based on the reaction between hydrazine and OPA through a unique mechanism at pH = 1.5 [23]. A carbon paste electrode modified by Ni(II) complex-ZrO_2 nanoparticles serves as an ultrasensitive electrochemical sensor for the determination of N-acetylcysteine in urine [24].

Other sensing designs include gaseous NH_3 detection by the selective formation of blue indophenol dye through modified Berthelot's reaction on porous paper [25]. A portable test paper, in which *o*-phenylenediamine as the reactive recognition site and benzothiadiazole as the fluorophore moiety are coupled, can be facilely fabricated for visual detection of oxalyl chloride and phosgene (two toxic gases) in the gas phase [26]. A partially reduced graphene oxide innercoated and fiber-calibrated Fabry–Perot dye resonator is good for biochemical detection of dopamine, nicotine, and single-stranded DNA [27].

In conclusion, this special issue aims to explore new insights on, and unique applications of, chemical reagents for sensor design and development. Potential applications can range from environmental analysis to industrial analysis. We look forward to receiving your new manuscripts in the upcoming weeks for reporting your research work and sharing your scientific wisdom.

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