Biofunctionalzed Carbon Nanotubes Sensors for Discriminate Detection of Organophosphorus Compounds

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A novel, multifunctional biocomposite sensor has been fabricated to demonstrate discrete and discriminate detection of Organophosphorus (OP) neurotoxins. Organophosphorus neurotoxins are widely used as agricultural pesticides and chemical warfare agents due to their acute toxicity, and they present a threat to food safety and homeland security. Using layer-by-layer assembly, a versatile, robust, simple, and inexpensive nanofabrication technique, a multi-compound sensor has been fabricated, which is able to discriminate between OP and non-OP neurotoxins. This is enabled through multiwalled carbon nanotubes (MWNT) that have been functionalized with biopolymers to facilitate charge transfer and stable catalysis over long periods of time. Polycationic MWNT-polyethyleneimine (PEI) and polyanionic MWNT-DNA are alternatively adsorbed onto the glassy carbon or carbon ink electrodes to form a cushioning support, and then polycationic MWNT-Organophosophorus Hydrolase (OPH) and polyanionic MWNT-Acetyl cholinesterase (AChE) are alternatively adsorbed to form the catalysis layers. Paraoxon, a model OP, is detected directly and immediately by catalytic hydrolysis to electroactive p-nitrophenol (enabled by OPH), while also being indirectly detected by inhibition of AChE, when it is exposed to the sensor. Acetylthiocholine (ATCh) serves as the analyte for AChE, which is hydrolyzed to electroactive thiocholine and detected electrochemically. AChE is inhibited irreversibly by many neurotoxic compounds, including those of the OP and non-OP chemical class. By measuring the amount of inhibition and relating it to the direct signal from OPH, a distinction can be made between the amount of OP and non-OP neurotoxin present in the sample. This system also demonstrates the possibility of multi-target systems that will allow for design and realization of biosensing systems for many different analytes, especially in complicated cases when a direct “one analyte – one biorecognition element” detection pathway will be impossible to accomplish and a series of different recognition events might be needed to achieve a final result.