FLEXIBLE ENERGETICS TRACE DETECTION SCHEMES UTILIZING ORGANIC ELECTROCHEMICAL TRANSISTORS

Efficiently identifying commercial and improvised explosives is a crucial prerequisite for disarming and disposing of these dangerous materials. In conjunction with traditional techniques (e.g., ion mobility spectrometry and mass spectrometry), electrochemical sensors can function as low-form factor and inexpensive options to quickly identify chemical threats. In particular, organic electrochemical transistors (OECTs) have many attractive properties, and they have become viable options for biosensing. OECTs employ a simple geometry consisting of a conducting polymer active layer and an electrolyte controlled by a gate electrode. In turn, this provides a means for the solution-phase detection in short times. Here, the OECT architecture was extended to the challenge of explosive trace detection. These sensors were adapted to detect several families of explosives (i.e., acid-salts, nitroaromatics, nitroamines, nitrate-esters, and peroxides). Many of these sensors incorporated molecularly imprinted polymers (MIPs) to improve chemical selectivity. These MIPs were shown to introduce size exclusive properties to the OECTs, which can be leveraged to detect acid salts explosives. MIPs that were complementary to nitrated explosives (nitroaromatics, nitroamines, and nitrate-esters) also were prepared. These MIPs can adsorb their respective explosive decreasing their polymer porosity and ion-transport. Finally, a stand-alone OECT design was applied to detect peroxide-based explosives. These explosives were decomposed to hydrogen peroxide intermediates. The evolved hydrogen peroxide was then identified as it was electro-oxidized at the gate electrode. After establishing the viability of the discussed techniques, two new directions for designing OECT sensors were proposed. Finally, these two outlooks were combined as a potential strategy for directly detecting peroxide-based explosives. While only a small subset of explosives was considered, the strategies applied were not unique to these specific targets. Indeed, these OECTs detecting principles could be applied to a broader scope of explosives detection as well as novel chemical sensing horizons.