Chapter 8
Employing Nano-Sensors for Explosives Detection

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ABSTRACT

This chapter presents the potential of the application of nano-sensors for trace explosive detection. A major challenge faced in detecting trace explosives is the detection of ultra-low quantities of trace compounds. This chapter discusses the selective and sensitive detection of trace explosives by employing nano-sensors, limitations of detecting trace explosives, and reevaluates the current technologies that are inefficient and inaccurate for trace explosive detection. Application of nano-sensors for the exposure of low concentration explosive compounds is an effective platform in the advancement of trace explosive detection.

INTRODUCTION

A reactive substance containing significant amount of potential energy is called as explosive, when suddenly released, rapidly and spontaneously decays with the progression of substantial amounts of heat and gas. Explosions caused by explosives are typically complemented by the assembly of light, sound, pressure, and heat.

The potential energy stowed in the explosive substances can be:

- Grain dust or nitroglycerin as chemical energy
- BLEVE or aerosol can and gas cylinder as compressed gas
- Isotopes of plutonium-239 and uranium -235 as nuclear energy

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The pace at which explosive materials expand can be used to classify them. Low and high explosives are terms used to describe materials that detonate (faster than the speed of sound the chemical reaction mechanism passes through the material). Explosives can also be divided into groups based on how sensitive they are. Primary explosives are materials that can be ignited by relatively low levels of pressure and heat, whereas secondary and tertiary explosives are constituents that are comparatively insensitive.

Many different substances have the potential to detonate, albeit fewer are produced with the intention of being used as explosives. The remainder is too risky, expensive, unstable, decomposition prone, hazardous, delicate, or degradation quickly.

On the other hand, some substances are flammable or combustible only if they burn without detonating. The change is not significant, though. Under normal circumstances, some substances—powders, volatile organic liquids, dusts, powders, or gases —may only be inflammable or combustible, but in certain circumstances or under certain conditions—such as confinement or quick release—they may turn explosive (Meixner, Fleischer, Kern, Sheremet, & McMillan, 2022).

Classification of Explosives

Low Explosives

Low explosives typically deflagrate as opposed to detonating. 2000 < 3000 feet per second is the range of their reaction times. A nice illustration is black powder. These materials often have a enlivening influence during blasting, high flammability, low water resistance, and sensitivity to #6 blasting cover. Typically, low explosives are not as effective in breaking rock as high explosives (Viswanath, Ghosh, & Boddu, 2018). When triggered, low explosives like black powder and nitrocellulose self-ignite very slowly, releasing massive volumes of gas in a clear and controllable manner. Explosives of numerous varieties are produced (Shreve & Brink Jr, 1977).

High Explosives

A high explosive is any compound blend that explodes with a counter speed in more than 5,000 feet per second. Primary or initiation and secondary explosives are further categories for explosives. Due to their high sensitivity, initiating explosives are typically utilized in small quantities in percussion caps and detonators to set off greater amounts of secondary explosives. Nitramines, nitro compounds, and nitrates, in particular are far less sensitive to thermal or mechanical shock but detonate with a powerful explosion when ignited by the starting explosive. TNT (2,4,6-trinitrotoluene) and ammonium nitrate explosives are the primary secondary explosives created for both industrial and military applications (Shreve & Brink Jr, 1977). The blasting cap no. 8 is used for commencing the reaction. High explosives are:

1. **Straight Dynamite:** Nitroglycerin travels at speeds of between ten and twenties of thousands of feet per second and is absorbent. This dynamite is the most sensitive explosive ever used in trade. The filling's nitroglycerin content can be precisely determined by weight strength. This explosive has poor fumes, good water resistance, and poor cohesiveness.
2. **Ammonia Dynamite:** The solitary difference between ammonia and regular dynamite is that precise amount of nitroglycerin has been replaced by ammonium or sodium nitrate as well as different carbonaceous fuels. Three types of ammonia dynamite exist: High Density: The detonation veloc-