Chapter 13
Role of Quantum Dots in Volatile Poison Detection

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ABSTRACT

Volatile poisons are volatile organic carbon-based compounds that easily release from indoor surroundings (for example paints, furnishings, building materials) or industry productions because of their relatively low boiling points. The detection of volatile toxins can be done in a variety of ways. Various kinds of sensors have been created to analyze volatile organic toxins. Volatile poison sensors are generally easy to use, inexpensive, programmable, and portable. Future developments will include innovations or combinations of advanced technologies for volatile poisons sampling, detection, and analysis, as well as validation and standardization of these methods for practical clinical use. This chapter will provide an overview and critical analysis of the sampling, collecting, detection, and analytical techniques linked to volatile substances, with a focus on current advancements in nanomaterials such quantum dot-based sensors.

INTRODUCTION

Analytical environmental control needs to develop appropriate sensors which can make reliable and fast detection as well as measurement of environmentally important chemical compounds. From a broad range of pollutants, the control of high-vapor-pressure toxins in term of the volatile organic species is

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very essential in work-related protection and health control (for example) in atmospheres of workplace) as they can generate the harmful effects on health of human beings.

Due to their desirable characteristics, such as strong visible-band absorption, superior mechanical, and high electrical conductivity features, developing nanomaterials can now be employed to customize optical and electrochemical (bio)sensors. In fact, a wide range of nanomaterials are used, including spheres and particles [metallic nanoparticles (NPs), quantum dots (QDs), and magnetic beads], nanorods, nanotubes, nanofibers, and nanowires, as well as nanocomposites made of nanopolymers, nanofilms, and nanoplates (Arduini et al., 2020; Wang et al., 2023). In this light, it is noteworthy that the configuration of nanomaterials and biomaterials plays a significant role in the design of hybrid nanostructured instruments to achieve “greater operational/storage stability, resistance, response time, ease of sampling, low sample volume and better selectivity with increased detection performance” (Arduini et al., 2016; Munteanu et al., 2023).

Volatile Poisons

The analytes known as volatile poisons are those whose chemical structures largely contain unstable carbon atoms that are unstable at room temperature. A volatile organic compound (VOC) is defined as “any organic compound possessing a 0.01 kPa or more vapour pressure at 293.15 K, or a resulting volatility under specified conditions of usage” in the EU Regulation on Emission Limitations for Volatile Organic Compounds. Since it has a low boiling point and a high vapour pressure, the organic component will evaporate at 20 °C in this case (room temperature). This feature allows the easy, quick, and imperceptible transmission of volatile poisons to humans through the air (Cumeras et al., 2019; Montero-Montoya et al., 2018).

Volatile poisons are the volatile organic carbon based compounds which easily release from indoor surroundings (for example paints, furnishings, building materials) or industry productions that are because of their relatively low boiling points. These compounds are discharged as gases from different liquids or solids. Organic molecules including alcohols, carbonyls, aromatics, alkanes, alkanes, esters, amides, and ethers can be released when you light a fire, cook, paint a house, drive a car, mow a lawn, use building materials, use pesticides, or simply breathe too much. Nearly all of a person’s daily activities result in the release of biological materials into the environment. Anthropogenic pollutants, such as hazardous gases and volatile organic compounds (VOCs), have been released since the Industrial Revolution through a variety of processes, including the petroleum industry (Han et al., 2023). Exhaust gases, water separation technologies, industrial wastewater, batch operations, petroleum refining, paint manufacturing, and petrochemical processing are a few examples of specific sources and processes that frequently produce considerable volumes of volatile pollutants. Thus, rising VOC emissions and their impact on air quality are now seen as a major environmental problem (Yang et al., 2023).

Concentrations of numerous organic toxic species are consistently higher indoors than outdoors (up to 10 times greater) and the air in workplaces, houses, schools, and other business buildings is thought to contain between 50 and 300 distinct VOCs at any given moment. Volatile organic species are emitted by thousands of products, comprising solvent-based paints, printing inks, many consumer products, petroleum products and organic solvents, pesticides, cleaning products, and furniture and construction. Thus, VOC levels are employed as parameters to measure indoor air quality in addition to other indications like temperature and CO_2 levels (Almaie et al., 2022).