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GAS Detector sensor of Biology System

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Abstract. Background: We discuss advances in bioimaging technologies and gas-phase molecular biosensors. These technologies selectively detect volatile biochemicals using the high resolution of biorecognition elements. Methods: Gas-phase biosensors employ enzymes as recognition components. These devices produce luminescent molecules and other detectable products through redox reactions of volatile biochemicals. Results: Biosensors utilizing other biorecognition elements, including molecularly imprinted polymers, olfactory receptors, cells, and antibodies, are demonstrated. When used in combination with optical, electrochemical, and liquid biorecognition components, biosensors exhibit a unique and powerful property: they are insensitive to humidity. This important feature enables biosensors to detect volatile biochemicals in the breath and other humid environments. The use of imaging technologies and improvements in recording the spatiotemporal distribution of volatile biochemicals with improved continuity are also discussed. Aims: These new techniques are expected to be used to monitor environmental volatile biochemicals with high resolution and identify the hitherto undiscovered relationship between health and spatial and temporal fluctuations in volatile biochemicals in skin or breath gas.

Highlights:

1. A gas detector sensor is used for the biology system to detect the presence of certain gases in the surrounding environment.
2. Used as part of a safety system to detect leaks of hazardous or flammable gases.
3. These sensors work by sensing changes in the concentration of gases in the air and alerting when a certain level is exceeded.

Keywords: Bioimaging Technologies, Gas-Phase Biosensors, Volatile Biochemicals, Biorecognition Elements, Humidity Insensitivity

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Introduction

Gas detection plays a pivotal role in ensuring safety, protecting the environment, and safeguarding human health. The ability to accurately detect and monitor gases is

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essential across various domains [1] ,including industrial operations, environmental conservation, and medical applications.

Methods

This research method uses an experimental and descriptive approach to test the ability of gas detection sensors in biological systems, including the preparation of natural reagents (such as sunflower litmus paper, red cabbage extract, turmeric, beet, and apple peel) as well as chemical reagents (acetic acid, ammonia, Tollens, Fenton, Collins, and magnesium reagents), which are then applied to the test media. Gas sensors with recognition elements based on enzymes, imprinted molecules, olfactory receptors, cells, and antibodies are calibrated using standard gases to determine sensitivity and response to humidity. Exposure tests are carried out by placing the reagents and sensors in a test chamber supplied with the target gas, followed by recording color changes or signals through bioimaging technology to analyze the spatial and temporal distribution of volatile compounds. The data is analyzed descriptively and quantitatively based on response time, signal intensity, and result stability, with all procedures following ethical approval from the environmental, health, and higher education research committee in Iraq.

Results and Discussion

A. Results

1. The Natural Reagents

Compounds that produce a noticeable physical change (colour) in the medium when their chemical composition changes. These reagents are collected from natural materials that interact with humans, like tea [2], rose flowers, and sage, in addition to the sunflower plant (litmus paper), which is a water-soluble mixture of several colours obtained from its blooms. This combination's CAS registration number is 1393-92-6. It is usually absorbed by a filter paper and used as a pH indicator to measure the acidity of an object [2]. The sunflower paper is wetted with distilled water to measure the pH of a gas. Sunflower paper exposed to some airborne gases may change colour, while neutral gases like oxygen and nitrogen do not modify the colour of the pH paper. However, other plant-based reagents, such as red cabbage, beets, blueberries, carrots, cherries, red onions,

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strawberries, purple grapes, turmeric, and apple peels, are now being sought after by scientists [3].

2. Chemical Reagents

Chemistry includes the study of all the properties of matter, starting with determining its composition, then its structure, the changes that occur within it, and its reactions [4]. It also studies atoms and the bonds that occur between them, forming molecules. Chemistry plays a crucial role in our lives, as it is involved in many industries and other fields, such as medicine. Chemistry is often called the central science, as it links all natural sciences together [5]. Therefore, there are several types of chemical reagents, depending on the type of elements that compose them:

a. First - Single-element reagents

Numerous chemical compounds and elements are included under each class in the table of chemical reagents. We raise the following point [6]:

1) Acetic acid: This organic acid is among the most basic carboxylic acids.
2) Acetone: Acetone is a chemical compound and the most basic kind of ketone.
3) Acetylene: The most fundamental alkene, acetylene is a colourless gas that is widely used as a component in fuels and chemicals [6].
4) The bulk of nitrogen-containing molecules are formed from ammonia gas, an inorganic material. It is used by the fertiliser industry.
5) In addition to conventional organic analysis, qualitative analysis also makes use of aqueous ammonia, sometimes known as ammonium hydroxide.
6) Azobisubisobutyronitrile: Rubber and plastics are often kept from flaking by using this chemical.
7) The existence of unsaturates that mimic double bonds in organic chemistry may be qualitatively assessed using Bayer's reagent, an alkaline potassium permanganate solution [7].
8) N-Bromosuccinimide: It is employed in organic chemistry to measure electrolytic addition reactions by substituting for radicals.

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9) The organic solvent methyl ketone, also referred to as butanone, has properties similar to those of acetone but a slower rate of evaporation.
10) The organic solvent butylhydroxytoluene is mostly used as an antioxidant in food. n-12.
11) Butyllithium: An organic material that starts polymerisation to produce elastomers such as styrene butadiene and styrene SBS.
12) Carbon disulphide: This nonpolar solvent is often used as a base in organic chemistry.
13) Carbon tetrachloride: Alternative solvents, such deuterated carbon, have replaced carbon tetrachloride because of its low solubility and toxicity.
14) In chemical synthesis and the coupling of amino acids to create peptides, carbonimidazole is a frequently used reagent.
15) Ammonium nitrate: An inorganic material that is used as an oxidising agent in organic synthesis and as a standard oxidising agent in quantitative analysis.
16) Rhodium chlorotris (triphenylphosphine) assembles and coordinates the homogenous catalytic conversion of alkenes to alkanes.
17) Chlorophore: It is an organic compound and a solvent. Chlorophore CHCl3 or chlorinated chlorophore is often used as a solvent in nuclear magnetic resonance spectroscopy.
18) Chromium acid: A strong oxidising agent that promotes corrosion, it is a component of chrome plating.
19) Chromium trioxide: Contains the acidic anhydride of chromic acid and is mostly utilised in chrome plating.
20) Collins reagent: It uses selective oxidation to convert primary alcohols into aldehydes.
21) Des-Martin: This reagent may oxidise primary alcohols to aldehydes and secondary alcohols to ketones.

b. Second - Multi-element Reagents

There are several types of chemical reagents, each of which contains numerous chemical compounds and elements, which will be explained as follows [8]:

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1) Magnesium Reagents

These reagents were named by the French scientist Victor Grignard and rely on the varying reactions of halogen compounds when reacting with magnesium. Alkyl halides react more rapidly than aryl chlorides, which react very slowly [9].

In other words, it is an organic derivative of magnesium called RMgX, where R refers to hydrocarbons such as CH3, C2H5, and C6H5. X also refers to halogen atoms, which are the seventh group in the periodic table, including chlorine, bromine, and iodine [8]. Mg means magnesium. These reagents are prepared by reacting halogens with magnesium in a general atmosphere dominated by nitrogen, because this reagent is highly reactive with both oxygen and moisture. The reactions of halogen compounds vary during the reaction with magnesium [9], as alkyl halides react faster than aryl chloride, which reacts very slowly, as in Figure (1).

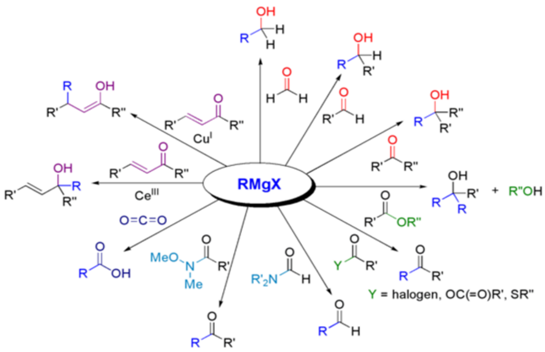

Figure 1. Magnesium Detector

2) Tollens' reagent

This is a chemical reagent used to detect the presence of normal aldehydes and aromatic aldehydes. It is prepared from a solution of ammonia and silver nitrate [10]This reagent tests for the presence of silver. If silver is present, or the test is positive, a silver mirror forms on the inner surface of the reaction. This reagent has no chemical formula and is named Tollens after its discoverer, the chemist Bernhard Tollens.

3) The Fenton reagent

This reagent is produced by reacting hydrogen peroxide with an iron catalyst. It reduces the levels of organic contaminants by generating

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hydroxyl radicals by chemical oxidation [11]. Other organic pollutants and chlorinated organic compounds are removed.

4) Collins' reagent

This reagent is a mixture of chromium oxide and pyridine with dichloromethane. It selectively oxidizes primary alcohols to aldehydes.

B. Discussion

In nuclear physics, nuclear engineering, and experimental and applied particle physics, a particle detector—also known as a radiation detector—is a device used to identify, track, and/or detect ionising particles, such as those produced by nuclear decay, cosmic decay of radiation, or interactions in a particle accelerator. Detectors may not only record the presence of a particle but also measure its energy and other properties like as charge, velocity, spin, and particle type [12]. Depending on the kind, intensity, and character of the radiation as well as the nature of the material, ionising radiation interacts with various materials to produce a range of effects. Materials that are affected by radiation in a way that allows for the utilisation of the resulting effect are known as radiation detectors. The formation of a quantity of electrical charges within the detecting material, also known as the effective volume of the detector, which gathers at the counter electrode, is the end result of the exchange of effects between radiation of various types, including charged particles, uncharged particles like neutrons, and even electromagnetic radiation, for the majority of detector types [13]. The majority of the detectors that have been created and used up to this point are ionisation detectors, including the most widely used gaseous ionisation detectors, semiconductor detectors, and scintillation detectors. However, other ideas have also been used, such as Cherenkov radiation, which is electromagnetic radiation emitted when a charged particle, such an electron, moves through an insulating material more quickly than light does in the same medium. When molecules in that medium are ionised, they quickly slow down and return to their previous state, which causes the release of Cherenkov radiation [13]as a byproduct. The blue light of nuclear reactors is caused by this radiation. It bears the name of Pavel Cherenkov, a Russian scientist who won the Nobel Prize for being the first to discover this radiation in a scientific experiment.

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The theory of this radiation was established by Igor Tamm and Ilya Frank, who both won the Nobel Prize, in the framework of transition radiation [14], and Einstein's theory of special relativity (Figure 2).

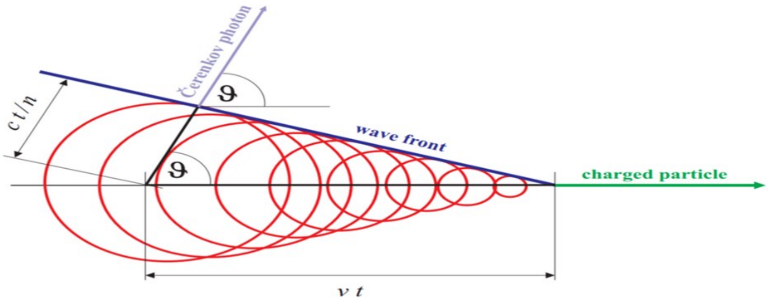

Figure 2. Cherenkov rays

Recently, Cherenkov radiation has been employed to examine specific parts of the body [15]. These findings have prompted a large amount of interest in utilizing this optical signal to both measure and detect radiation from internal sources (e.g)., radiopharmaceuticals that are internalized by the body as well as external sources (e.g)., external radiation that is used to treat tumors. Isotopes that are radioactive produce light that is perceptible. The imaging technology has demonstrated the capacity to identify these isotopes in humans. During external beam radiation therapy, electrons or photons with a energy range of 6-18 MeV have been shown to produce a large amount of Cherenkov light in the treated tissue [14]. These high-energy X-rays emit electrons that produce Cherenkov radiation. As can be seen in Figure (3), the detected signal is both audible and perceptible at the entrance and exit surfaces of the tissue [15].

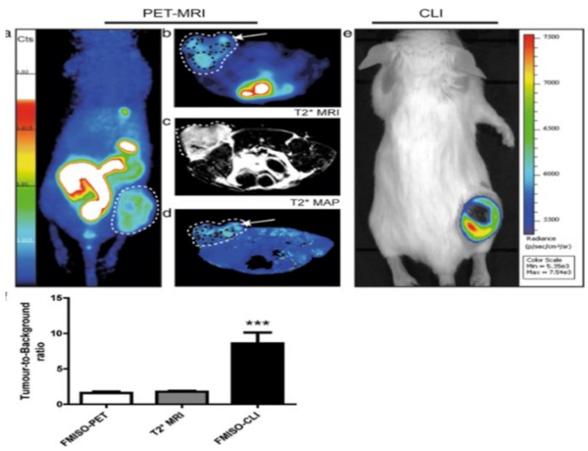

Figure 3. Cherenkov imaging

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Cherenkov radiation is used to recognize particles with an electric charge that is large. In open reactors, electrons with a high energy called a beta particle are released as a result of the disintegration of fission products [9]. This radiation is still present following the chain reaction's end and is reduced as the more temporary products diminish. Cherenkov radiation is also utilized to gauge the remaining radioactive content of spent nuclear fuel. Because of safety concerns, this phenomenon can be used to determine the presence of wasted fuel in wasted components. Similarly, energetic cosmic rays or photons of the gamma-region can interact with the Earth's atmosphere to produce pairs of electrons and protons that have a high velocity. These particles have a charge of +q and are released into the atmosphere. They produce Cherenkov radiation, which is used to determine the energy and direction of cosmic rays or gamma rays. For example, this approach is utilized by the Atmospheric Cherenkov Imaging Technique (IACT), experiments like VERITAS, H.E.S.S., and MAGIC utilize this method. When these charged particles reach Earth, they release Cherenkov radiation from water-filled containers used by the Pierre Auger Observatory, the Extended Air Shower experiment, and other organizations. A similar philosophy is employed by large instruments like Super-Kamiokande and the Sudbury Neutrino Observatory (SNO) [14]. Other projects utilize similar methods, such as the STACEE solar-powered observatory in New Mexico that functions as a nonvisualizing Cherenkov instrument.

Conclusions

1. Physical detectors play a significant role in biological detection.
2. Physical detectors have a greater ability to penetrate and detect biological objects.
3. Physical detectors are cheaper than biological detectors.
4. The analytical capacity of physical detectors is higher than that of biological detectors.

Conflict of interest: The authors declare that they have no conflict of interest.

Ethical Clearance: The research Ethical Committee at scientific research by ethical approval of both environmental and health and higher education and scientific research ministries in Iraq.

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