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A COMPREHENSIVE SYNTHESIS AND CHARACTERISTICS INVESTIGATION OF NANO ZnO THIN FOR SENSING SEVERAL CONVENTIONAL

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ABSTRACT
The unique data and results have been published in referred journals. But to achieve monodispersed Nano crystalline materials and thin films remains a challenge for us. There are reports to prepare monodispersed nanocrystalline materials and thin films by using ultrasonic atomization technique and ultrasonic spray pyrolysis (USP) technique. The toxic chemical threats can be classified into two basic types: chemical warfare agents (CWA) and toxic industrial chemicals (TIC). Especially the threat of TICs has been widely realized in the recent years. That is due to their easy availability due to wide industrial use. Although CWAs are gradually more toxic and thus more dangerous than TICs, the CWA threat is reducing since in 1997 by more than 160 nations ratified the chemical weapons convention (CWC). That convention prohibits the development, production, stockpiling and use of CWAs as well as many of their precursors. Moreover, nations who are members of the Organization for the Prohibition of Chemical Weapons (OPCW) are banned from trading with nations, which did not sign the convention. Nevertheless, well-trained terrorists may still obtain chemical weapons - either by synthesizing themselves or from the nations which do not belong to the OPCW.

KEYWORDS:- Nano ZnO Thin, Nano crystalline materials, ultrasonic spray pyrolysis, chemical warfare agents, toxic industrial chemicals

INTRODUCTION
Many industrial and commercial activities involve the monitoring and control of the environment, with applications ranging from domestic gas alarms, medical domestic apparatus to safety environment, and chemical plant instrumentation. The largest barrier to achieve improved process or environment control often lies at the interface between the system and the environment to be monitored, i.e. the sensor. Without sensors, significant advances in control and instrumentation will not be possible. The release of various chemical pollutants from industries, automobiles and homes into atmosphere has been causing the global environment issues such as acid rain, the global greenhouse effect and ozone depletion. Hazardous and toxic gases from automobile and industrial exhausts are the polluting the environment. In order to measure and control these gases, one should know the amount and nature of gases present in the environment. Thus the need to monitor and control these gases has led to research and development of wide variety of sensors using different materials and technologies. To increase the efficiency and capability of the

instruments in measurement and detection technology, to reduce the cost, shape, size, weight etc., it is necessary to introduce the sensors units at the input parts of domestic, industrial and scientific instruments.

HEALTH HAZARDS

Different gases cause various health hazards. Exposure to air pollution is associated with numerous effects on human health, including pulmonary, cardiac, vascular, and neurological impairments. The health effects vary greatly from person to person. On the basis of nature and kind of gases few health hazardous gases are discussed below.

(i) Ammonia (NH3)

Ammonia is utilized extensively in many chemical industries, fertilizer plants, refrigeration systems, etc. A leak in the system can result the health hazards. Ammonia is harmful and toxic in nature, the exposure of ammonia causes chronic lung disease, irritating and even burning the respiratory track, etc. Therefore all industries working on and for ammonia should have an alarm system detecting and warning for dangerous ammonia concentrations.

(ii) Carbon dioxide (CO2)

The atmospheric concentration of CO2 at present is about 356 ppm. The greenhouse contribution of CO2 is 50 %. If the present emission trend of CO2 continues, a global warming of 3.5 to 4.5 oC is likely to occur. It has been estimated that, the sea level may rise 0.5 to 1.5 m in the next 50 to 100 years. An increase in average global temperature is likely to increase the incidence of infectious diseases.

(iii) Chlorine (Cl2)

Chlorine is yellowish-green gas having pungent smell, which is explosively utilized in industrial applications such as to bleach paper pulp, to disinfect sewage and drinking water, etc. As it has wide range of applications, its toxicity can affect the health of humans in contact. Chlorine has excellent bleaching ability, but once it is discharged in aquatic systems, it interacts with other industrial effluents to produce a host of chlorinated organic such as dioxin. Dioxin persists in the environment for prolonged periods and has tendency to bioaccumulate in the food chains, which elicits toxic effects to humans, such as skin infection, psychological disorders and even liver damage.

(iv) Hydrogen (H2)

Hydrogen is an energy carrier has widespread application such as fuels. It is colorless and odourless gas. Its leakage cannot be noticed easily. This gas is potentially hazardous because of explosion possibility.

(v) Ethanol (C2H5OH)

Pure ethanol is called as an absolute alcohol. Ethanol is used for beverages, scientific and industrial purposes. Ethanol can be made by fermentation of sugars and it is the alcohol of all alcoholic beverages. The synthesis of ethanol in the form of wine by the fermentation of sugars of fruit juices was probably our first accomplishment in the field of organic synthesis. Sugars from a wide variety of sources can be used in the preparation of alcoholic beverages. Often, these sugars are from grains, so, ethanol is referred as "grain alcohol".

(vi) Liquefied petroleum gas (LPG)

Liquified natural gas (LNG) and liquified petroleum gas (LPG) are highly inflammable gases. They are explosively utilized in industrial and domestic fields as fuels. They are referred as town or cooking gases. Cooking gas consists chiefly of butane (55-vol %), a colorless and odourless gas. It is usually mixed with compounds of sulfur (methyl mercaptan and ethyl mercaptan) having foul smell, so that its leakage can be noticed easily. These gases are potentially hazardous because explosion accidents might be caused when they leak out by mistake. It has been reported that, at the concentration up to noticeable leakage, it is very much more than the lower explosive limit (LEL) of the gas in air. So, there is a great demand and emerged challenges for monitoring them for the purpose of control and safety applications in domestic and industrial fields.

(vii) Carbon monoxide (CO)

Heamoglobin (Hb) has about 210 times more affinity for CO than for oxygen, hence less oxygen up by heamoglobin, if CO is inhaled during breathing. When CO is inhaled during breathing, it combines with heamoglobin in the blood stream to form more stable complex known as carboxy-heamoglobin (CO-Hb).

SENSORS

The sensor is a device that receives a signal or stimulus and responds with an electrical, electronic or optical signal. According to the International Electrochemical Committee (IEC), Sensor is the primary part of a measuring chain which converts the input variable into a signal for measurement. According to Gopel et al, a sensor is an element with housing and electrical connections included and which incorporates some kind of signal processing (analog or digital). The sensor is the first element to input the information to be measured.

NEED OF SENSORS

Nowadays, there is a general opinion in both scientific and engineering community that there is an urgent need for the development of cheap, reliable sensors for the control and measuring systems, for the automation of services and for the industrial and scientific apparatus. The sensors are required basically for measurement of physical quantities and for use of controlling some systems. Presently the atmospheric pollution has become a global issue. Gases from auto and industrial exhaust are polluting the environment. The reducing gases such as CO, H2, C2H5OH, oxygenic gases such as: CO2, NOX, O2, CH3OH, CH4, odourous gases such as: NH3, H2S, explosive gases such as: C2H2, C2H4, C3H6, C3H8, LPG and, toxic gases such: CO, H2S, Cl2, NO2 etc. have to be controlled for the healthy survival of the living beings. Thus, there is an increasing concern about minimization of the emission of autointoxication and also to reduce emission of such unburnt hydrocarbons from automobile and industrial exhausts. In order to dectect, measure and control these gases, one should know the amount and types of gases present in the ambient. Thus the need to monitor and control these gases has led to the research and development of a variety of sensors using different materials and technologies.

SENSOR TECHNOLOGIES

A gas sensor technology has already grown to be indispensable for various aspects in our life. Yet further advancements of the technology are strongly needed in order to improve sustainability of our society and quality of life. Gas sensor technology is interdisciplinary indeed, so that collaborations among people working in different disciplines, ranging from the materials scientists to market developers, would be necessary to open new frontiers. Researchers should be well acquainted with the needs having emerged or newly emerging in the industry and society. The advancement of science and technology has given an opportunity to use different technologies for fabrication of sensors for getting better performance. Mainly three technologies are being widely used in fabrication of sensors viz., pellet, thin film and thick film technology.

1. Thin film sensor

Thin films as the name suggests are thin in nature. Generally thickness of thin films is less than 1 μm. Since the thickness of the film is less than the average mean free path, the resistance of thin film is quite higher than that of thick film. Thin film is defined as the film having thickness less than the average mean free path of an electron, in the medium.

2. Thick film sensor

To prepare thick films, the thixotropic paste of functional material is formulated and printed onto an insulating substrate in a definite pattern. The thick film technique involves screen-printing followed by firing process. For thick film technology, paste of the functional material is prepared with the use of some temporary organic binder to achieve adhesion of a film to the substrate. The paste is screen-printed on an insulating substrate (e.g. glass), which can stand at higher temperatures, using screen-printing to get definite pattern. The printed film is dried under an IR lamp to remove the temporary organic binder and then it is fired at a higher temperature with a definite time-temperature profile to obtain stability and better adhesion of the film to the substrate.

3. Pellet

The pellet technique requires die and hydraulic press. Functional material and binders (e.g. Polyvinyl Alcohol (PVA), Sodium Carboxyl Methyl Cellulose) are thoroughly mixed together in a medium, which depends on solubility of binder. The mixture is dried to obtain the fine powder. The powder in kept in a die and pressed under high pressure. The thickness of the pellets can vary as per the requirement and diameter depends on the die. Thickness of the pellets is in the range of few millimeters. The pellets are fired to evaporate organic binder and to give more strength.

GAS SENSING MECHANISM OF METAL OXIDE SEMICONDUCTOR (MOS) GAS SENSOR

The gas sensing mechanism involves number of steps described as below: The oxygen gas molecule adsorb on the surface of the thick film. The surface of the sensor should be clear and large so that, the gas molecules can easily adsorb on it. The exposed target gas molecules are oxidized by capturing the atomic or molecular oxygen, which holds the electron on the surface, trapping behind the electrons constituting the increase in surface current. The surface is the region where the periodicity of the crystal is interrupt. Because of this, localized energy levels are form in forbidden gap. Such energy levels can either capture electrons or give up electrons. In case of semiconductor, like

SnO2 and Cr2O3, which are ionic, their surface metal ions capture an extra electron (act as an acceptor) and the surface oxygen ions give up electron (act as donar). The donar levels completely ionized if they are near the conduction band; however, if the donar are little below the conduction band, the donar levels are not completely ionized at room temperature. Donar levels get ionized above room temperature. The test gas present in ambient react with oxygen ions and gives a counter reaction. The trapped electrons are liberated to the conduction band, thereby increasing the conductance of the semiconductor.

CONCLUSION

A chemical agent's ability to be weaponized depends on its own unique features. Lethal agents aim to harm or disable the enemy. Fast-acting defoliants are intended to destroy vegetation and prevent it from being used as cover or concealment. It can also be used to cause famine and starvation by targeting farmland and livestock. The major impacts of chemical weapons can be countered with sufficient protective clothing, training, and decontamination techniques. Many countries have massive arsenals of chemical and biological weapons ready to be used in times of conflict. Threats, both real and imagined, have evolved into strategic planning instruments for both actions and counteractions. A chemical warfare/weapon agent (CWA) is a chemical substance whose toxic properties are used to kill, injure or incapacitate. About 70 different chemicals have been used or stockpiled as chemical weapon agents during the 20th century. These agents may be in liquid, gas or solid form. Furthermore, in the case CWAs, OPCW provides 43 chemical groups or specific chemicals in three schedules. All together, the request for number of chemical agents to be detected and identified by CWA-TIC detector raises easily over 150 agents providing an extreme challenge for the detector developers. Fortunately, many suitable sensor and spectrometer technologies have been demonstrated and are also available in the market. Detectors deploy for example ion mobility spectrometers, IR spectrometers, flame photometric detectors, solid-state gas sensors and electrochemical sensors and their combinations. Basic key figures of these CWA-TIC detectors are detection, identification and quantification performance. Also response time can be considered as a key figure. Other favoured features are the capability of continuous operation, low weight, small size and ease of operation. However, any of the CWA-TIC detectors available in the market today does not meet all the requirements regarding detection and identification performance and other technical challenges. Therefore, there is still significant need for further technology development.

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