ZnO Nanorods Based Hydrazine Sensors

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Electrochemical sensor for the detection of hydrazine has been fabricated at the surface of gold electrode modified with ZnO nanorods. The ZnO nanorods were grown by non-catalytic simple thermal evaporation process by using metallic zinc powder in the presence of oxygen at low-temperature. The detailed structural studies revealed that the as-grown ZnO nanorods are well-crystalline with the wurtzite hexagonal phase and grown along the [0001] direction in preference. A good and reproducible sensitivity of 4.76 μA cm⁻² μM⁻¹ has been obtained from the fabricated hexagonal-shaped ZnO nanorods based electrochemical sensor. The response time of the fabricated sensor was less than 10 s with a linear range from 0.2 to 2.0 μM and correlation coefficient of \( R = 0.9914 \). The limit of detection (LOD), based on S/N ratio was estimated to be 2.2 μM.

**Keywords:** Electrochemical Sensor, ZnO Nanorods, Hydrazine.

1. INTRODUCTION

Hydrazine is one of the most commonly analyzed compounds in the industrial and environmental samples owing to its toxic effects on humans. It is widely used as catalysts, emulsifier, corrosion inhibitor and antioxidants, reducing agents, pesticides and plant growth regulators.¹ ² In pharmaceuticals also, the hydrazine has much importance as it has been recognized as carcinogenic and hepatotoxic substrates which affects the liver and brain glutathione.³ Moreover, electro-oxidation of hydrazine is the basis of an established fuel cell, due to its high capacity and no contamination. In addition to this, hydrazine is widely used as high-energy propellants in rockets and spacecrafts by military and aerospace industries.⁵ Therefore, due to aforementioned applications in industry, environment and pharmacology, it is very important to develop a reliable, cheap and effective method for the efficient detection of hydrazine. Among various detection techniques, the electrochemical techniques offer an opportunity for portable, cheap and rapid methodologies. Therefore, numerous chemically modified electrodes, based on different electrocatalytic moieties (electron-mediator species), has thus been developed for the detection of hydrazine and reported in the literature.⁶ Recently, scientists have demonstrated the use of semiconductor nanostructures as electron mediators to modify the electrodes for the electrochemical detection of hydrazine.⁷ ¹¹ ¹²

Among various semiconductor nanostructures, wurtzite hexagonal phase ZnO nanostructures presents itself as one of the most promising materials due to its versatile properties₁³–₂₃ which includes its non-toxic nature, electrochemical activities, chemical and photochemical stability, high-specific-surface area, optical transparency, high-electron communicating features and so on. Even though having versatile properties, but the electrochemical amperometric sensor application of ZnO is still rare as yet. Few reports on the utilization of ZnO nanostructures are reported in the literature._²₄–₂₆_ In this paper, we report the fabrication of electrochemical sensor for the detection of hydrazine using well-crystallized ZnO nanorods grown by non-catalytic simple thermal evaporation process. A good and reproducible sensitivity of 4.76 μA cm⁻² μM⁻¹ and detection limit of 2.2 μM have been obtained from the fabricated ZnO nanorods based electrochemical sensor. Moreover, the response time of the fabricated sensor was less than 10 s with a linear range from 0.2 to 2.0 μM and correlation coefficient of \( R = 0.9914 \).

2. EXPERIMENTAL DETAILS

Single-crystalline hexagonal-shaped ZnO nanorods were prepared via non-catalytic thermal evaporation process by using high-purity metallic zinc powder in the presence of oxygen. The experimental setup consists of a horizontal quartz tube furnace with the halogen lamp heating system, a rotary pump system and a gas controlling system.