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Short Communication

Nanomaterials for Monitoring Glucose in Diabetes

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Monitoring blood glucose levels assists diabetics in controlling their condition on a personal level, minimizing the negative effects of numerous other diseases associated with diabetes. Due to the short comings of current diagnostic techniques, many researches are being done to create more accurate ways to test glucose. There has been a huge need for the creation of advanced glucose biosensors for the human society. Research has mainly concentrated on attaining biocompatible and better sensing capabilities in comparison to the current technologies, which opens up new avenues for more effective glucose sensors. These efforts have been impacted by nanotechnology because of the unique properties of nanomaterials such as increase in the surface area of sensors, and enhances the catalytic properties of electrodes. Here, we will review the recent advancements in glucose biosensor based on nanomaterials that enhance the glucose sensor performance.

The major problem of diabetes demands attention which is marked by an elevated blood glucose level [1-3]. According to the World Health Organization (WHO), millions of individuals worldwide, particularly those from middle- or low-income groups, are affected by diabetes mellitus. If left untreated, it could result in serious side effects such kidney failure, blindness, heart attacks, strokes, and limb amputations [4]. Despite the fact that there is no cure for diabetes, people can lessen its side effects by closely monitoring their blood glucose levels. The development of affordable, accurate, and user-friendly glucose monitoring instruments is being sparked by advancements of nanoscience and nanotechnology. Accurate and timely detection based on several kinds of glucose sensor platforms has been made possible by using nanomaterial based biosensors. With the use of nanomaterial based biosensor, the sensing properties enhanced by many fold as shown in the schematic (Figure 1).

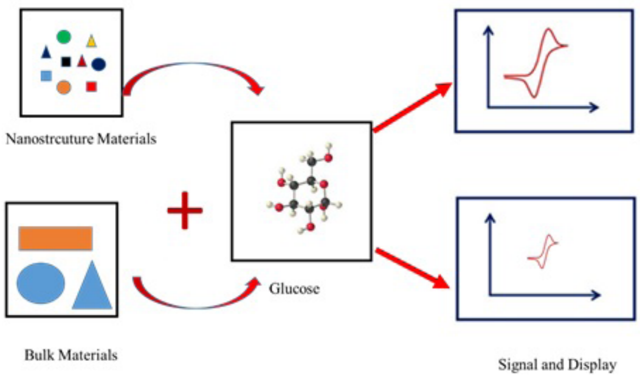

Figure 1: Schematic figure for comparison of bulk and nanomaterial based glucose sensors.

Nanomaterials Based Glucose Sensors

The enzyme-based electrochemical glucose sensor is the type that has been studied the most historically. Based on the 1960s-era hypothesis of immobilizing GOx on an electrode, most researchers studied this type of glucose biosensor [5]. The most typical use of nanotechnology for diabetes sensors is the use of nanomaterials to help with the conventional enzymatic electrochemical detection of glucose as shown in (Figure 2). Other glucose identification techniques should be used for optical glucose sensors in the absence of electrodes and the electrochemical process. The use of common enzymes, such GOx, with optical glucose-sensing technologies, particularly fluores-

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cent sensing, is also possible. Photoluminescence quenching is one of the most suitable methods for detection of glucose in human blood serum (Figure 2b) as studied by Sarangi et al. [6]. One of the underlying ideas is that when enzymes or coenzymes bind to glucose, their optical characteristics would alter. Increased surface area, more effective electron transport from enzyme to electrode, and the opportunity to incorporate extra catalytic processes are just a few benefits that come with incorporating nanomaterials into these sensors.

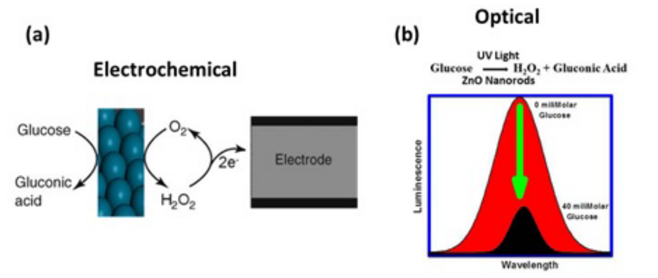

Figure 2: (a) Electrochemical glucose sensor, **(b)** Optical glucose sensor.

Using the nanomaterials, one may characterise recent advancements in glucose biosensor sector. Porous films, nanoflowers, and nanorods, as well as copper based nanostructures have been studied to demonstrate glucose detection [7-10]. There have been reports of nanoparticles made of silver, gold, nickel, and nickel/palladium, as well as gold, boron-doped diamond, and platinum/lead [11-18] nanoporous networks for glucose detection using electrochemical methods. Moreover, the incorporation of carbon nanomaterials into glucose sensor application enhances sensor performance. Metal nanoparticles with carbon nanofibers or nanotubes [19,20], and fluorine-doped nanotubes [21] have improved oxidation characteristics (such as working potential or sensitivity) when compared to direct oxidation systems with an unmodified electrode which resulted an enhancement in the sensing properties. Similar to this, Kim et al. [22] and Sarangi et al. [6] created an optical glucose sensor using ZnO nanostructures that was both enzymatic and non-enzymatic. In this optical glucose sensor, photoluminescence quenching caused by H_2O_2 as a result of the oxidation of glucose with GOx caused the PL intensity to decrease with the glucose concentration. The radiative transition of the excited electrons was blocked by the quencher H_2O_2, which led to the PL quenching. The quantum confinement that aided in the electron transport from ZnO to H_2O_2 boosted the energies of the valence and conduction band edges. The PL intensity can be utilised as a gauge of the glucose concentration since the amount of PL quenching correlates with the amount of H_2O_2, which also correlates to the glucose concentration.

We have compiled the recent developments used in glucose sensor applications. The greater lifetime and shorter readout lag of optical glucose sensors have made them a popular alternative to electrochemical sensors in recent years. The most common form of glucose sensors used in the different commercially available glucose monitors nowadays are electrochemical sensors. Although the majority of conventional electrochemical sensors are enzyme-catalyzed, modified electrodes based on nanotechnology, particularly those made of metal, nanoparticles, or graphene, have been developed in an effort to replace the enzyme with electrodes that perform glucose sensing more effectively. Moreover, several of the nanomaterials-based glucose sensors have been used extensively in optical glucose sensors and are thought to be efficient glucose recognition techniques. The optical glucose-sensing method that has received the most research attention in the literature based on photoluminescence/fluorescence technique

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