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The Properties that Biosensors Acquire as a Result of Using Stainless Steel in Their Manufacturing.

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Abstract- *Stainless steel is gaining attention as a key biosensor material due to its durability, corrosion resistance, biocompatibility, and cost-effectiveness. Its unique properties, such as electrical conductivity and mechanical strength, make it ideal for applications in healthcare, environmental monitoring, and food safety. Recent advances have highlighted its use in electrochemical, optical, and mechanical biosensors, including wearables for continuous blood glucose monitoring. Fabrication techniques such as nano- structuring modification and microfabrication further improve its performance. Stainless steel-based biosensors offer an affordable and efficient alternative to traditional methods, enabling real-time detection with high sensitivity and reliability. The findings showed that Stainless steel has gained attention as a biosensor material due to its excellent mechanical properties, corrosion resistance, and ease of fabrication, in addition the integration of Stainless steel electrodes in biosensors represents a significant advancement in the field, driven by their durability, cost-effectiveness, and electrochemical performance, moreover the biocompatibility of stainless steel makes it suitable for in vivo applications, while its conductivity allows for efficient signal transduction in electrochemical biosensors.*

Keywords- *Stainless Steel, Biosensors, Corrosion Resistance, Fabrication Techniques.*

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I. INTRODUCTION.

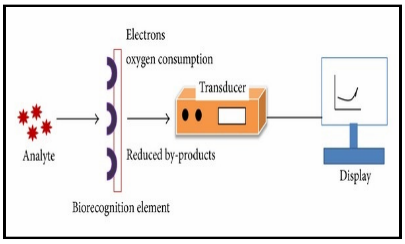
Stainless steel (SS) is a versatile iron alloy that has exceptional resistance to corrosion and this remarkable property comes from chromium, an alloying element that constitutes at least 10.5% of the composition of steel. When exposed to oxygen, chromium forms a thin, invisible, and self-healing layer of chromium oxide on the steel's surface. This passive film acts as a protective barrier, preventing further oxidation and effectively shielding the underlying metal from corrosives [1]. A biosensor is a self-contained integrated analytical device capable of providing specific quantitative or semi-quantitative analytical information using a biological recognition element (biochemical receptor) retained in direct spatial contact with an electrochemical transduction element.

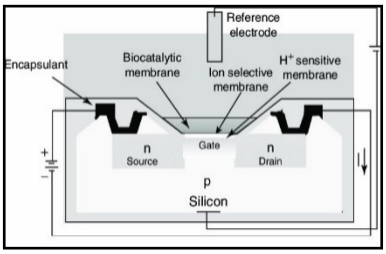
The key components of a biosensor include the bio- receptor, which is a biological element (e.g., enzyme, antibody, nucleic acid) that specifically interacts with the target analyte, and the transducer, which converts a biological recognition element (biochemical receptor) retained in direct spatial contact with an electrochemical transduction element. The key components of a biosensor include the bio-receptor, which is a biological element (e.g., enzyme, Biological recognition of antibodies event into a measurable signal (e.g., electrical, optical, thermal) [2].

Biosensors are widely used in healthcare, environmental monitoring, and food safety due to their high sensitivity, specificity, and rapid response times. Recent advancements in biosensor technology have focused on improving the materials used for fabrication, with stainless steel emerging as a promising candidate due to its durability, biocompatibility, and cost-effectiveness [3].

Stainless steel has gained attention as a biosensor material due to its excellent mechanical properties, corrosion resistance, and ease of fabrication. Its biocompatibility makes it suitable for in vivo applications, while its conductivity allows for efficient signal transduction in electrochemical biosensors [4].

The advancements in biosensors technology are particularly significant given the limitations of traditional methods, which often require expensive equipment and labor-intensive sample preparation processes to detect harmful compounds or other analytical species, such as hepatotoxins [5]. As an alternative, biosensors, including those based on stainless steel, have emerged as compact and affordable analytical tools that translate biological reactions into electrical signals, providing real-time information about the concentration of the target substance [6]. There are a lot types of biosensors based on stainless steel in their manufacturing such as Electrochemical biosensors, Optical biosensors, and Mechanical Biosensors Figure-1 showed two types of Biosensors as examples. This study aims to reveal the characteristics gained by using stainless steel in the manufacturing materials of biosensors.





(a) **(b)**

Figure 1: Showed two Types of Biosensors. (a) Electrochemical Biosensor, (b) Potentiometric Biosensor.

II. FABRICATION TECHNIQUES OF STAINLESS STEEL -BASED BIOSENSORS.

The fabrication of stainless steel-based biosensors involves several key techniques as the following:

1. **Surface Modification**: Stainless steel surfaces are often modified to enhance biocompatibility and sensor performance. For instance, (Zhang *et al*, 2020) used surface treatments to improve the electro-chemiluminescent properties of stainless-steel electrodes.
2. **Nano structuring**: The integration of Nano-materials, such as gold nanowires, can significantly enhance sensitivity and flexibility. (Li *et al*,2022) demonstrated this by decorating stainless steel wire sieves with gold nanowires, resulting in a highly sensitive glucose sensor.
3. **Microfabrication**: Techniques such as photolithography and etching are used to create micro sensors. (Wang *et al*, 2021) employed microfabrication to evelop a disposable stainless steel-based electrochemical micro sensor for in vivo applications.

III. RESULTS AND DISCUSSIONS.

The reviewed studies collectively highlight the versatility and efficacy of stainless steel (SS) electrodes in bio sensing applications, particularly for detecting hepatotoxins, mycotoxins, and other analysts. (Rozman *et al*, 2022) demonstrated the utility of SS electrodes in a HepG2 cell-based biosensor for hepatotoxins detection, emphasizing their biocompatibility and electrochemical stability. This aligns with the findings of (Wang *et al*, 2022), who reviewed advancements in biosensors for mycotoxin detection, noting the growing preference for durable and cost-effective materials like SS in sensor fabrication.

The electrochemical performance of SS electrodes was further validated by (Zhang *et al*, 2020), who utilized SS for sensitive luminal electro-chemiluminescent detection of H_2O_2, glucose, and oxidase activity. This study underscores the material's ability to facilitate high-sensitivity detection, a critical requirement in bio-sensing. Similarly, (Li *et al,* 2022) developed a wearable electrochemical glucose sensor using SS, demonstrating its flexibility and sensitivity, which are essential for real-time monitoring applications. These findings collectively suggest that SS electrodes can be engineered to meet the demands of both laboratory-based and wearable biosensors. In the context of hepatotoxicity, (Luo et al, 2021) provided insights into the mechanisms of natural products causing liver damage, which complements the work of (Rozman *et al,* 2022) by offering a biological framework for understanding the toxins detected by SS-based biosensors. Additionally, (Ye *et al,* 2019) explored aptamer-based biosensors for marine toxin detection, further expanding the scope of SS applications in environmental and food safety monitoring.

The integration of SS electrodes in biosensors represents a significant advancement in the field, driven by their durability, cost-effectiveness, and electrochemical performance. The studies reviewed demonstrate that SS can be tailored for various bio-sensing applications, from detecting hepatotoxins and mycotoxins to monitoring glucose levels and environmental contaminants. The biocompatibility of SS, as evidenced by its use in cell-based biosensors (Rozman *et al,* 2022), further enhances its appeal for biomedical applications.

IV. CONCLUSIONS.

The following conclusions have been drawn from this study:

1. Stainless steel has gained attention as a biosensor material due to its excellent mechanical properties, corrosion resistance, and ease of fabrication.
2. The biocompatibility of stainless steel makes it suitable for in vivo applications, while its conductivity allows for efficient signal transduction in electrochemical biosensors.
3. The integration of Stainless steel electrodes in biosensors represents a significant advancement in the field, driven by their durability, cost-effectiveness, and electrochemical performance.
4. Cost-Effectiveness of Stainless steel compared to other materials like gold or platinum, stainless steel is more affordable, making it ideal for disposable and large-scale biosensors.

Future work should aim to address existing limitations and explore new applications, ensuring that SS-based biosensors continue to meet the evolving demands of healthcare, environmental monitoring, and food safety.

REFERNCES.

[1]. Rozman, M., Štukovnik, Z., Sušnik, A., Pakseresht, A., Hočevar, M., Drobne, D., & Bren, U. (2022). A HepG2 Cell-Based Biosensor That Uses Stainless Steel Electrodes for Hepatotoxin Detection. *Biosensors*, *12*(3), 160.

[2]. Luo, X., Zhang, Y., Wang, Y., & Liu, Y. (2021). Hepatotoxicity and its mechanisms of natural products. Frontiers in Pharmacology, 12, 660469.

[3]. Wang, Y., Wang, L., & Wang, X. (2022). Recent advances in biosensors for mycotoxin detection. Trends in Analytical Chemistry, 149, 116594.

[4]. Zhang, X., Li, Q., & Zhao, Y. (2020). Stainless steel electrode for sensitive luminol electrochemiluminescent detection of H O , glucose, glucose oxidase activity. *Biosensors &Bioelectronics, 150*,11.

[5]. The Editors of Encyclopaedia Britannica. (2024, July 19). *Stainless steel*. Encyclopedia Britannica

[6]. Ye, W., Liu, T., Zhang, W., Zhu, M., Liu, Z., Kong, Y., & Liu, S. (2019). Marine Toxins Detection by Biosensors Based on Aptamers. *Toxins*, *12*(1), 1.