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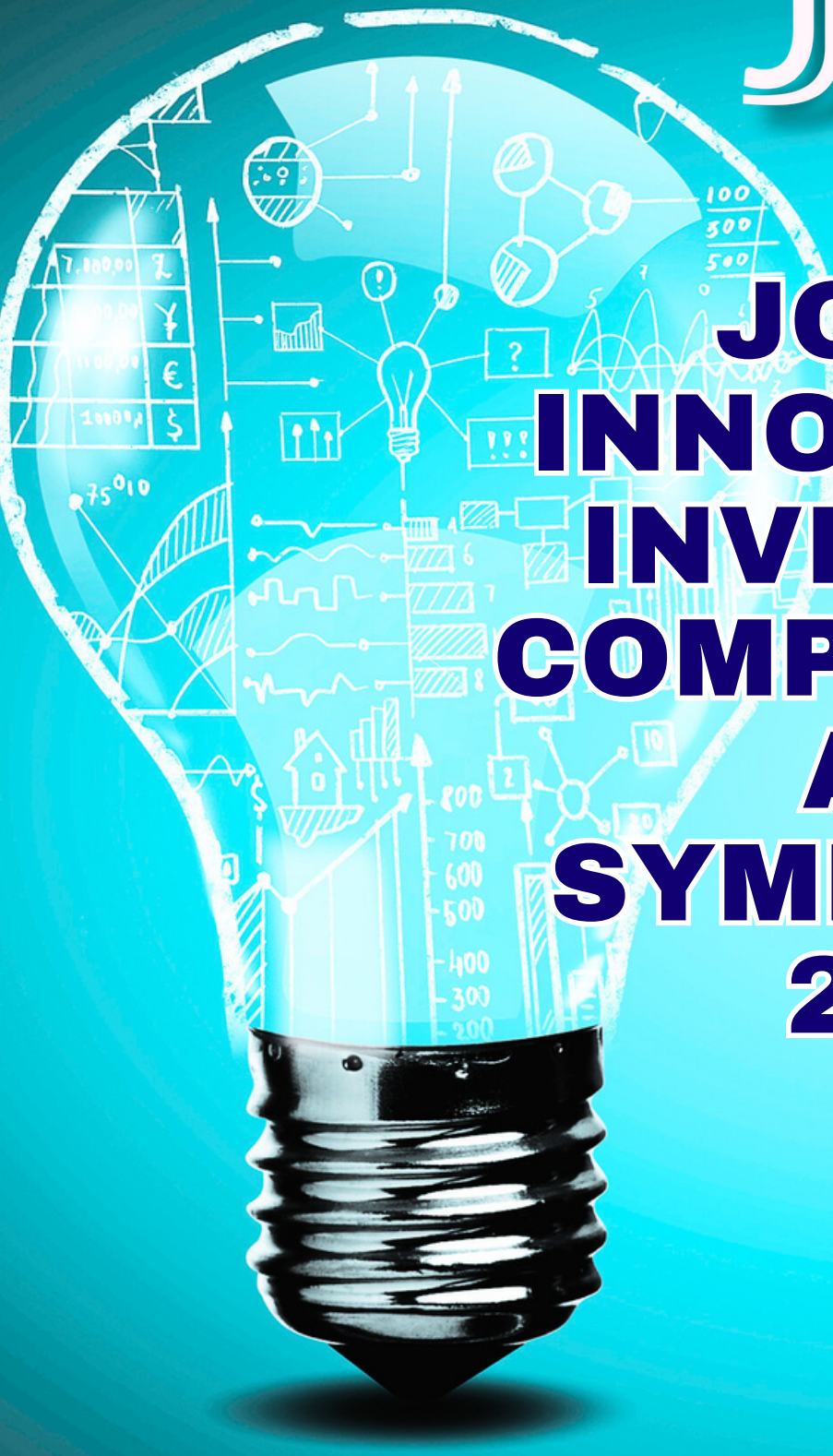

JOHOR INNOVATION INVENTION COMPETITION AND SYMPOSIUM 2023

" Innovation Inspires a Society to be Critical and Creative"

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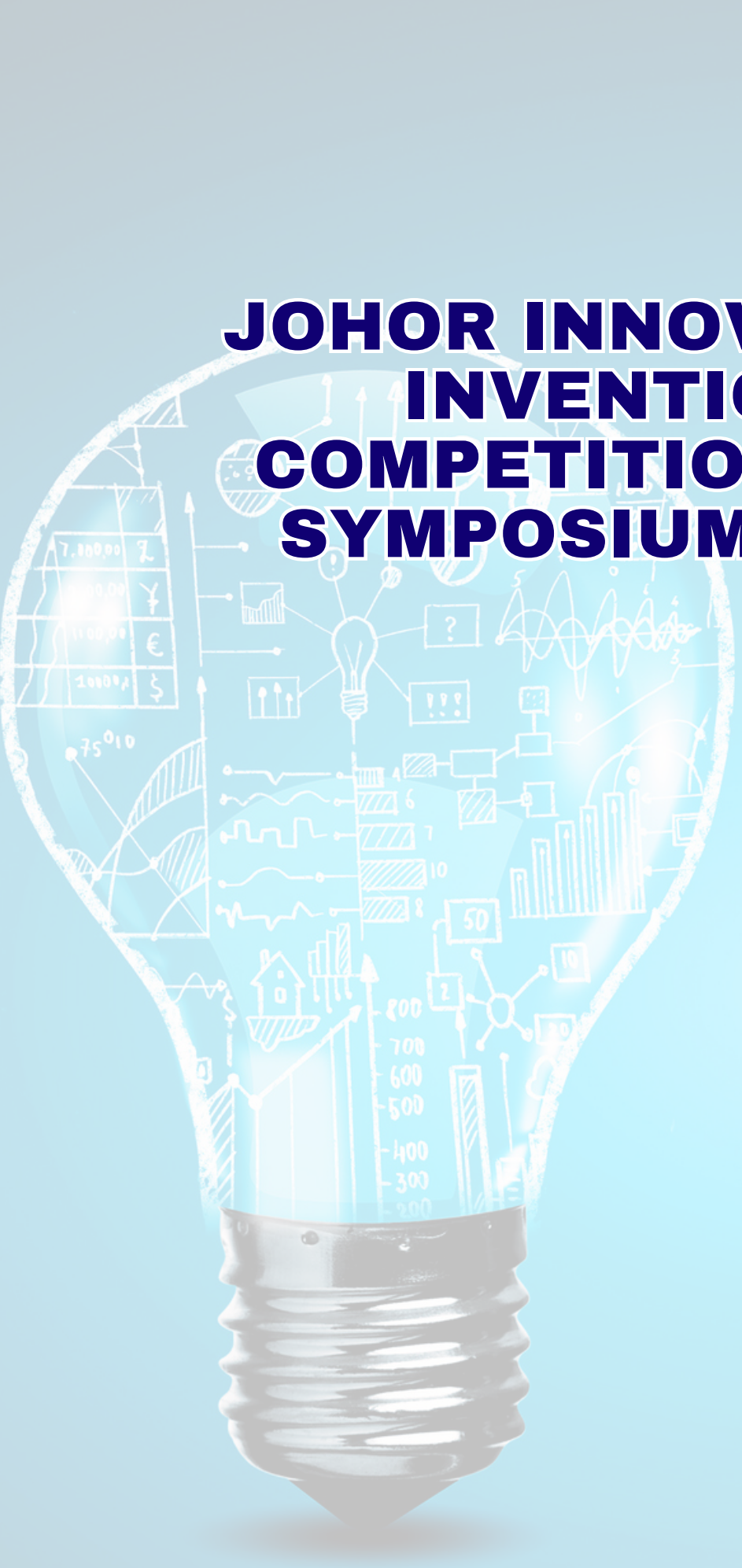

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Editors-in-Chief

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Preface

In the name of Allah, the Almighty who gives us the enlightenment, the truth, the knowledge and with regards to Prophet Muhammad (peace be upon him) for guiding us to the straight path. We thank to Allah for giving us guidance and strength to write this e-book.

This e-book compiles the extended abstracts that submitted to Johor Innovation Invention Competition and Symposium 2023 (JIICaS2023), where JIICaS2023 is a virtual platform for all creative minds to share and present their invention and innovation. The extended abstracts are divided into two categories, which are Category A (Higher Educational Student/ Any Recognized Institutional Students in Malaysia) and Category B (Primary/ Secondary School Students / Special Education School Students in Johor). Each abstract gives a brief background on the innovation or project.

We hope that this e-book will help the readers to get to know the innovation done by the students from both categories and get some ideas to develop future innovation products.

A053

DEVELOPMENT OF INTEGRATED MICROFLUIDIC PLATFORM RAPID TEST KIT FOR FAST DETECTION OF INFLUENZA A

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ABSTRACT

The recent increases in influenza A cases in Malaysia have raised public concern due to the ability of the virus to cause respiratory infections. There are several diagnostic methods available to detect the influenza A virus such as reverse transcript-polymerase chain reaction (RT-PCR) and rapid influenza diagnostic tests (RIDTS). However, these methods are time consuming and expensive. Moreover, other available fast diagnostic method can be less accurate and thus, resulting to false negatives. Therefore, a rapid test kit (RTK) with high accuracy and sensitivity for the detection of influenza A is highly required. In this study, a simple test kit for the detection of influenza A is proposed by using surface-enhanced Raman Spectroscopy (SERS) technique integrated with microfluidic devices containing microchannels. The detector will be prepared from material functionalized with a composite of silver (Ag)-doped carbon nanotubes (CNT) and carbon nitride (CN). The use of CNTs material to capture the viruses obtained from various biological fluids, such as saliva and nasal samples can be an effective method to produce result with high sensitivity. The detection and sensing of the influenza A virus will be based on their Raman Signature. The SERS technique used in this study to detect the presence of virus will be enhanced by the Raman effect that provided by plasmonic material (Ag) when it doped with the composite (CNT-CN). Due to the intertubular distance of CNTs that matches with the size of the virus, it can be used to trap and concentrate the virus at the detector. Hence, these properties allow for the detection of the virus at low concentration level. Provided that the device is successfully developed and proven to reliably detect the virus, this proposed RTK could be a important diagnostic tool to prevent another major pandemic.

Keywords: Influenza A; RTK; carbon nanotubes; carbon nitride, biosensors.

1.0 INTRODUCTION

Type A Influenza virus or commonly known as Influenza A is the virus that can cause flu outbreaks. This virus has been reported to cause serious respiratory infections in both human and animals (Peiris *et al.*, 2009). Although the virus is not usually dangerous for a healthy person, it can cause serious health problems for those with certain medical conditions (Javanian *et al.,* 2021). There are several techniques and methods for detecting the influenza A virus, including reverse transcriptase-polymerase chain reactions (RT-PCR) and rapid influenza diagnostic tests (RIDTs) (Morehouse *et al.,* 2022). However, the current methods are expensive and take a longer time to complete. Therefore, a new method to detect influenza A with fast and high accuracy is suggested. In this study, we propose a prototype of a RTK prepared from microchannel integrated platforms that are coupled with silver (Ag) functionalized carbon nanotubes (CNTs) and carbon nitride (CN) for detection of influenza A

virus in the body fluids, such as saliva or nasal samples, by using surface-enhanced Raman Spectroscopy (SERS) technique. The proposed RTK will be following the method outlined by Jadhav *et al.* (2021) except for the addition of Ag and CN. The proposed RTK is expected to show high sensitivity due to the ability of CNTs to trap the virus. Hence, allowing the virus to be concentrated at the detection point (Yeh *et al.,* 2016). In addition, the intensity of Raman Signal will be enhanced upon functionalization with Ag due to its plasmonic properties (Moore *et al.,* 2018). The enhanced Raman Signal will also allow the detection of the virus at low concentration levels, especially for infected individuals at early stage. Moreover, the incorporation of CN into tubular CNTs will also improve the SERS and sensing performance. Therefore, it is expected that by trapping the respective virus using modified microfluidic device coupled with SERS can be useful in detecting influenza A viruses obtained from body fluids sample (Yeh *et al.,* 2020). Based on the aforementioned properties, the proposed technique is also expected to have the ability to detect mild cases by using SERS technique. This is important as it would help identify the asymptomatic cases in order to reduce and prevent transmission of the virus.

2.0 OBJECTIVE

The objective of this study is to develop a rapid test kit for the detection of influenza A with high accuracy and high sensitivity using SERS technique coupled with plasmonic materials (Ag). The test kit will be developed using composite of CNTs and CN, while the surface of CNTs will be doped with Ag. Additionally, the proposed rapid test kit is designed to be low-cost and convenient to use.

3.0 DESCRIPTION OF INNOVATION/METHODOLOGY

The proposed rapid test kit (Figure 1) will have a similar design to a commercial test kit. The test kit will be prepared using a composite of CNT/CN doped with Ag. CNT/CN is used as it has strong resonance scattering and the ability of CNT to trap the virus. The incorporation of CN in CNT will improve the SERS properties. Meanwhile, plasmonic material, Ag will be doped with CNT/CN in order to enhance the intensity of Raman Signal. The influenza A viruses will be trapped within the tubular structure of CNT and the presence of CNT will help concentrate the virus obtained from body fluids sample such as saliva or nasal. The detection of the virus with high accuracy and sensitivity in the saliva sample using the SERS technique will take only a few minutes. If proven successful, this test kit could become the method of choice worldwide.

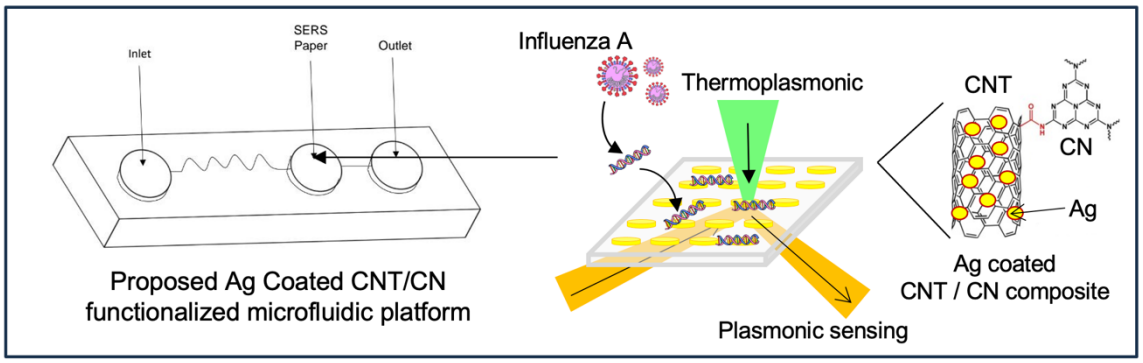

Figure 1: Description of test kit

Therefore, it is expected that this test kit could offer a long-term alternative for the diagnosis of influenza A virus. Furthermore, the development of this test kit could serve as a guideline for designing portable platforms to detect future viruses and prevent viral pandemics.

4.0 ADVANTAGE/IMPACT/RESULTS/NOVELTY

In addition to its application in detecting the influenza A virus, the proposed test kit can also be further developed to detect various types of viruses, enabling universal virus detection. The use of CNTs can help concentrate the virus by trapping it within their tubular structure, thus allowing the detection of the virus at lower concentration. Hence, it can be used to detect individuals with asymptomatic infections, reducing the possibility of transmission. In term of the usage, it is designed to be user-friendly. Trained non-medical workers and volunteers can conduct rapid tests, including self-administered ones, with minimal need for special equipment. This is particularly beneficial in regions that have restricted resources or limited access to specialized laboratories. With these advantages, it can have a huge impact on society, where they can save time as the rapid test kit only takes 20 minutes or less to get their results.

5.0 CONCLUSION

It is proposed that this invention could provide valuable diagnostics for the field of biomedical science, contributing to the initiative of reducing viral infections, particularly Influenza A. Consequently, the development of this fast, highly accurate, and sensitive test kit will facilitate the design of future kits to prevent future outbreaks.

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