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Electronic Properties of Synthetic Shrimp Pathogens-derived DNA Schottky Diodes

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The exciting discovery of the semiconducting-like properties of deoxyribonucleic acid (DNA) and its potential applications in molecular genetics and diagnostics in recent times has resulted in a paradigm shift in biophysics research. Recent studies in our laboratory provide a platform towards detecting charge transfer mechanism and understanding the electronic properties of DNA based on the sequence-specific electronic response, which can be applied as an alternative to identify or detect DNA. In this study, we demonstrate a novel method for identification of DNA from different shrimp viruses and bacteria using electronic properties of DNA obtained from both negative and positive bias regions in current-voltage (I–V) profiles. Characteristic electronic properties were calculated and used for quantification and further understanding in the identification process. Aquaculture in shrimp industry is a fast-growing food sector throughout the world. However, shrimp culture in many Asian countries faced a huge economic loss due to disease outbreaks. Scientists have been using specific established methods for detecting shrimp infection, but those methods do have their significant drawbacks due to many inherent factors. As such, we believe that this simple, rapid, sensitive and cost-effective tool can be used for detection and identification of DNA from different shrimp viruses and bacteria.

Since the discovery of the double helix structure of DNA by Watson and Crick in 1953, DNA has been described as the basic building block of life[1,2]. DNA electronics gave birth to the idea, and the possibility of nucleic acid assisted production of the small-scale electronic devices and denser circuits. It has been the subject of intense investigation over the past decade due to its essential role in the operation of electronic devices[3]. In recent years, researchers have utilised new device production methods due to the difficulties and limitations of conventional technologies when it comes to nano-scale processing[4]. Over the past few decades, DNA has been demonstrated to play crucial roles in overcoming these barriers in electronic devices because of its semiconducting-like[5] or diode-like behavior[6]. This electronic feature of DNA allows possible applications in various fields such as biology, physics, chemistry, computer science and engineering to develop a small, simple, rapid and sensitive electronic device[3].

Diodes are electronic devices which allow current to flow in one direction only. Common I–V graphs of diodes depict an exponential growth in the current with a small increase in the voltage, also known as rectification behaviour[7]. In this work, we utilise the DNA molecules to create a DNA-metal (semiconductor-metal) device and study the effect of electric current conduction across it. Previous works have indicated that DNA has rectifying properties. By sandwiching the DNA with a metal, we can create a form of diode known as the Schottky

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