Optimizing use of Pyrediyne quantum dots as biosensors for SARS-CoV-2 detection

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Abstract

The first reported case of COVID-19 was in Wuhan, China in December 2019 after which it spread all around the world and was declared a pandemic by WHO on March 11, 2020. As the pandemic progressed, the scientific community was faced with the challenge of diagnosing, treating, and isolating the infected patients. Asymptomatic carriers and false-negative results were a few of the major challenges which revealed the shortcomings of detection techniques. Now, in series of constant strive researchers are working to develop advanced techniques, nano-particles (NPs) based biosensing approaches can be a hope offering novel diagnosis meeting the current demand of rapid and early detection of COVID-19 cases. Gold NPs, lanthanide-doped NPs, oxides of carbon, and graphene NPs in combination with amperometric, calorimetric, and fluorescence techniques are in practice for SARS-CoV-2 biosensing. Pyrediyne a non-toxic carbon based nano-particles (NPs) with enhanced electronic properties and 25% progressive photoluminescence quantum yield could set up standards for detection of SARS-CoV-2. Effortless and cost-efficient preparation of pyrediyne quantum dots (PQD) will be carried out via the soxhlet extraction method. Characterization of the average size <10nm by high-resolution transmission electron microscopy (HRTEM) followed by the visibility of the lattice fringes and absence of sharp peaks in X-Ray Diffraction (XRD) pattern further can confirm the semi-crystalline nature of quantum dots. After cell viability analysis, PQD can be used for the visual detection of COVID-19 antibodies. Further, this cost-effective approach can be used as biological recognition system in a biosensor. Therefore, this work will offer an intuitionist method in the biosensing and clinical diagnosis of COVID-19.

Compared to organic fluorophores, the narrower emission band and wider absorption bands of QDs offer great advantages in cell imaging and biosensor applications. The optoelectronic features of QDs have prompted their intensive use in bioanalytical, biophysical, and biomedical research. As the nanomaterials have been integrated into microfluidic systems, microfluidic technology has accelerated the adaptation of nanomaterials to clinical evaluation together with the advantages such as being more economical, more reproducible, and more susceptible to modification and integration with other technologies. Microfluidic systems serve an important role by being a platform in which QDs are integrated for biosensing applications. As we combine the advantages of QDs and microfluidic technology for biosensing technology, QD-based biosensor integrated with microfluidic systems can be used as an advanced and versatile diagnostic technology in case of pandemic. Specifically, there is an urgent necessity to have reliable and fast detection systems for COVID-19 virus. In this review, affinity-based biosensing mechanisms which are developed with QDs are examined in the domain of microfluidic approach. The combination of microfluidic technology and QD-based affinity biosensors are presented with examples in order to develop a better technological framework of diagnostic for COVID-19 virus.

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