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Recent Trends and Analysis of Virological Generated Diseases and Application of Optical Engineering in the Process of Detection

Vijay Laxmi Kalyani[1], Dr. V. K. Sharma[2]

[1]Ph.D. research Scholar, ECE Department, Bhagwant University, Ajmer, Rajasthan, India
[2]Professor, ECE Department, Bhagwant University, Ajmer, Rajasthan, India

ABSTRACT

Abstract: Virological diseases continue to threaten human life. These are caused by the viruses which are very small infectious agents. They are much smaller than bacteria and made up of a piece of genetic material (DNA or RNA) that is enclosed in a coat of protein. Viruses invade cells in human body and use components of those cells to help them multiply. This process damages or destroys infected cells. Therefore, a specific analytical method is necessary for virus detection. To detect various virological disease optical engineering plays very important role. With the help of optical based biosensors fast and reliable detection of various virological generated disease can be possible. Optical based bio-sensors are useful for detecting a variety of bio-targets cause of diseases such as cells, pathogens, proteins, antibodies, and nucleic acids with high efficiency and selectivity. This technology is fast, pathogen specific and it does not require any chemical modification of the test sample. Therefore, a fast, accurate and reliable diagnosis mechanism is require to save lives. In this paper we are going to discuss about the various virological generated diseases and how the optical engineering help to detect these diseases in early stage so that the diagnosis can be made easy.

Key words: optical sensors; recent advancement; Virological diseases

INTRODUCTION

Virological disease caused by the viruses. Viruses have caused some of the most dramatic and deadly disease. Subsequently, most of these causing agents have become common viruses with different epidemiological trends. In many countries of the world and poor segments of modern society, several contagious diseases such as Dengue, malaria, Cancer, Human Immunodeficiency Virus, COVID-19 virus are affecting lots of people and also continue to create significant health problems. Notably, COVID-19 outbreaks worldwide have attracted attention in the last years Dec. 2019. There have been 456,797,217 confirmed cases of COVID-19, including 6,043,094 deaths, reported to WHO [1]. To detect various disease conventional diagnostic method like RT-PCR (Reverse Transcriptase Polymerase Chain Reaction) is a time consuming process and this technique requires expensive equipment and reagents for the diagnosis purpose. Therefore, for early and fast detection of various virological generated disease development of new technologies are in demand. Optical technology is one of the most promising approach to satisfy the growing demand for effective medical diagnostic technologies. Nowadays optical technology based biosensors are in demand due to their fast, reliable, sensitive, small in size, low power consumption etc. Many type of biosensors have been designed and developed by the scientists, researcher and engineers in the field of bio sensing applications, which has subsequently been adopted into clinical practice.

By 2020, the global biosensors market size is anticipated to reach USD 21.17 billion, among which optical biosensors are identified as the most lucrative technology segment. This represents just a fraction of the estimated USD 72 billion worldwide markets for in vitro diagnostics (IVD) [2].

The global biosensors market size was valued at USD 22.4 billion in 2020 and is expected to expand at a compound annual growth rate (CAGR) of 7.9% from 2021 to 2028. Because biosensors, owing to their ability to assess health status, and disease onset and progression, are being used extensively in-home healthcare by patients, and hence, are expected to boost market growth over the forecast period. Furthermore, technological advancements, as well as various non-medical-based applications are expected to enhance the applicability of the market for biosensors, thus promoting its growth [3]. Furthermore, the growing population worldwide is expected to drive the market for biosensors. The current world population is 7.9 billion in which India is the second largest populated country in the world [4].

Since the population are increasing day by day include the increasing prevalence of target diseases such as dengue, cancer, COVID-19 virus etc. Thus, increasing demand for inexpensive and reliable tool, biosensors are in demand.

REVIEW OF LITERATURE

In the review of literature, many types of photonics crystal based biosensors have been developed by the researchers to detect various virological disease. The work already done on the photonics based sensors by various researchers in the past few years have been discussed in this section:

Fleming Dackson Gudagunti et al. designed and simulated a 2-D photonic crystal based ring resonator biosensor with point and line defects which was detected early stage breast cancer .Finite difference time domain (FDTD) method was used for analysis and MEEP tool were used to modelling and designing a ring resonator based biosensor. The proposed work used Si rods are used in air background, square symmetry are used. Lattice constant a=100 nm and radius is 190 nm, dielectric of Si is 11.56, 1550 nm Gaussian continuous wave with 0.4 centre frequency and 0.3 width of pulse are used in the input side. The wavelength peak was compared and corresponding shift was observed between normal cell and breast cancer cell [5]. Saronika et al. designed a nanocavity-coupled photonic crystal waveguide as highly sensitive platform for cancer detection. A bio-sensing platform based on nanocavity-coupled photonic crystal waveguide was proposed for diseased cell detection. The Proposed label-free waveguide-cavity coupled nanostructure with high-Q was designed and analyzed to exhibit high sensitivity and high selectivity against five different cancer cells. The introduction of a nanocavity in the PCW leads to a sharp resonance which makes it useful for detection of infected cells. 2-D Finite Difference Time Domain (FDTD) method was used in the proposed design [6].Pavel Damborsk´y et al. represented an Optical biosensors the most common type of biosensor.

They provided a brief classification, a description of underlying principles of operation and their bioanalytical applications. The main focused was placed on the most widely used optical biosensors which were surface plasmon resonance (SPR)-based biosensors including SPR imaging and localized SPR. Other optical biosensor systems were also described, such as evanescent wave fluorescence and bioluminescent optical fibre biosensors, as well as interferometric, ellipsometric and reflectometric interference spectroscopy and surface-enhanced Raman scattering biosensors. The optical biosensors discussed allow the sensitive and selective detection of a wide range of analytes including viruses, toxins, drugs, antibodies, tumour biomarkers and tumour cells [7]. Nuree Lee et al. proposed a user-friendly and highly sensitive detection method for influenza A (H1N1) virus using the cooperation of quantum dot (Qdot)-aptamer beacons and light guide in a three-dimensional (3D) photonic crystal (PC) [8]. Bakr Ahmed Taha et al. presented a review work in which the detection of coronavirus disease 2019 (COVID-19) technologies were summarized and discussed with a comparison between them from several aspects to arrive at an accurate decision on the feasibility of applying the best of these techniques in the biosensors that operate using laser detection technology [9].

Mr. Hemanth Kumar et al. presented a biosensor based on 2D photonic crystal was designed which can detect infected platelets in the Wavelength range of 1620 nm to 1800nm. The proposed biosensor for dengue detection has a quality factor of 104.33 and sensitivity of 50 nm/RIU. The holes in the sensor was filled with platelets of sample blood. The sensing mechanism is based on change in the refractive index of the normal platelet and infected platelet which leads to the change in peak resonant wavelength. Finite Difference Time Domain method was used for the analysis [10]. Srinivasan Kuppuswamy et al. computed the refractive indices of different corona viruses (H5N1, H5N2, H9N2, H4N6, FAdV and IBV) through reflectance analysis of a virus solution. The computational analysis indicates that the refractive indices of all viruses are negative at the signal of 412 nm. Further the numerical output shows that the infectious bronchitis viruses (family of novel corona viruses, COVID-19) have higher negative refractive indices as compared to other corona viruses. Finally refractive indices of the family of COVID-19 were investigated with respect to the EID (Electronic infusion Device) concentration of the viruses, showing that the refractive index which ranges from “-0.96725 to -0.999998” corresponds to ‘0.01 to 10000’ EID virus concentration [11].

As the optical technologies have enhanced sensing performance in the field of device miniaturization, fluidic device, and light-analyte interaction and optimized the size of sensor, they are in great demand. Therefore in this paper we are focusing on analysis of various Virological diseases and applications of optical engineering in the process of detection.

VARIOUS VIROLOGICAL DISEASES

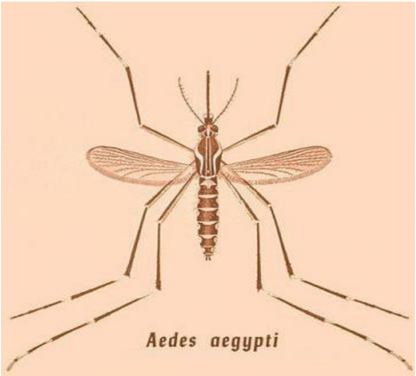
Virological diseases caused by the viruses which are smaller than bacteria and having the capacity of fast replication and distribution in host body. They are made up of a piece of genetic material like DNA or RNA,that is enclosed in a coat of protein. They enter in the host body and use their machinery for metabolism and self-replication and hence cause disease. This become a severe threat to human health.

Viruses lack the capacity to survive and replicate outside of a host body. They have been the cause of several diseases, such as Japanese encephalitis, Chikungunya, dengue, Ebola, influenza, hepatitis, flu, chicken pox, AIDS, severe acute respiratory syndrome (SARS), Cancer, Human Immunodeficiency Virus, COVID-19 and several others. A transportable viral particle comprises nucleic acids and an external shell of proteins. Therefore, a specific analytical method is needed for early virus screening and analysis.

In this section, we will present an overview of some most common Virological diseases.

Dengue:

Dengue is the most common and important arthropod-borne viral (arboviral) illness in humans. It is transmitted by mosquitoes of the genus Aedes [12].Dengue is a viral infection transmitted to humans through the bite of infected mosquitoes. The virus responsible for causing dengue, is called dengue virus (DENV). There are four DENV serotypes and it is possible to be infected four times. Severe dengue is a leading cause of serious illness and death also. There is no specific treatment for dengue/severe dengue. Early detection of disease progression associated with severe dengue, and access to proper medical care lowers fatality rates of severe dengue to below 1% [13]. Mild symptoms of dengue can be confused with other illnesses that cause fever, aches and pains, or a rash. The severe symptoms of dengue are Belly pain, tenderness, Vomiting (at least 3 times in 24 hours), Bleeding from the nose or gums, Vomiting blood, or blood in the stool, Feeling tired, restless, or irritable.



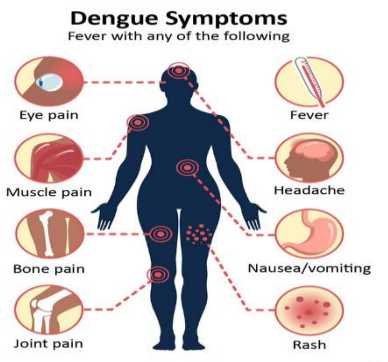


Fig.1: Image of mosquitoes of the genus Aedes Fig.2: Image of dengue symptoms Source:
https://emedicine.medscape.com/article/215840-overviewSource: https://www.cdc.gov/dengue/symptoms/index.html

Laboratory diagnosis methods for confirming dengue virus infection may involve detection of the virus, viral nucleic acid, antigens or antibodies, or a combination of these techniques. After the onset of illness, the virus can be detected in serum, plasma, circulating blood cells and other tissues for 4–5 days. During the early stages of the disease, virus isolation, nucleic acid or antigen detection can be used to diagnose the infection. At the end of the acute phase of infection, serology is the method of choice for diagnosis [14].

Traditionally, dengue diagnosis can be achieved via virus isolation, immunological-based tests or the molecular-based polymerase chain reaction (PCR). However, these techniques are costly, have a long turnaround time and require specialized equipment and training. Therefore new methods are required for fast diagnosis. In recent years, dengue rapid diagnostic tests (RDTs) have been developed commercially to detect dengue NS1 antigen, IgM and IgG antibodies to dengue virus from whole blood, serum or plasma. These RDTs are based on the immunochromatographic method and are presented in a lateral flow cassette that draws specimen via capillary action and the results can be obtained in less than 30 minutes [15].

Cancer:

Cancer is a disease in which some of the body's cells grow uncontrollably and spread to other parts of the body. Nowadays about 15%-20% of cancers have a viral cause, including Burkitt's lymphoma (Epstein-Barr virus), cervical cancer (human papillomavirus), and liver cancer (hepatitis B and C viruses) [16]. Cancer is a leading cause of death worldwide, accounting for nearly 10 million deaths in 2020, or nearly one in six deaths. The most common cancers are breast, lung, colon and rectum and prostate cancers. Around one-third of deaths from cancer are due to tobacco use, high body mass index, alcohol consumption, low fruit and vegetable intake, and lack of physical activity. Cancer-causing infections, such as human papillomavirus (HPV) and hepatitis, are responsible for approximately 30% of cancer cases in low- and lower-middle-income countries. Many cancers can be cured if detected early and treated effectively [17]. Cancer can start almost anywhere in the human body, which is made up of trillions of cells. Normally, human cells grow and multiply to form new cells as the body needs them. When cells grow old or become damaged, they die, and new cells take their place. Sometimes this orderly process breaks down, and abnormal or damaged cells grow and multiply when they shouldn't. These cells may form tumors, which are lumps of tissue. Cancerous tumors spread into, or invade, nearby tissues and can travel to distant places in the body to form new tumors (a process called metastasis). Cancerous tumors may also be called malignant tumors [18].

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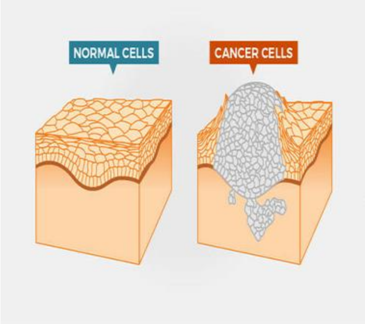

Fig.3: Image of normal cell and cancer cell
Source:https://www.cancer.gov/about-cancer/understanding/what-is-cancer

3. Influenza: Influenza is a viral infection that attacks on the human respiratory system like nose, throat and lungs. It is commonly called the flu. For most people, the flu resolves on its own. But sometimes, influenza and its complications can be deadly. Influenza viruses are of four types: A, B, C and D. Human influenza A and B viruses cause seasonal epidemics of disease which is known as flu season. Influenza-A viruses are known to cause flu pandemics, i.e., global epidemics of flu disease. A pandemic can occur when a new and different influenza-A virus emerges that both infects people and has the ability to spread efficiently among people. Influenza C virus infections generally cause mild illness and are not thought to cause human epidemics. Influenza D viruses primarily affect cattle and are not known to infect or cause illness in people [19].

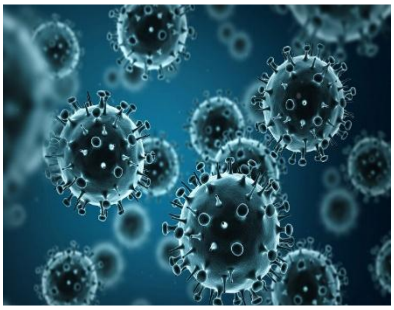

Fig.4: Image of Influenza viruses
Source: https://i0.wp.com/www.nfid.org/wp-content/uploads/2019/08/Flu.jpg?ssl=1

Influenza (flu) is a contagious viral infection that can cause mild to severe symptoms and life-threatening complications, including death, even in healthy children and adults. Influenza viruses spread mainly from one individual to another through coughing or sneezing. Less often, they can also spread through touching a contaminated surface and then touching the mouth, eyes, or nose. Individuals can pass flu on to others even before their own symptoms start and for a week or more after symptoms begin [20].

COVID-19

A recent example of viral infection is the COVID-19 pandemic. It is an infectious disease caused by SARS coronavirus-2. On 11 March 2020, WHO declared Novel Coronavirus Disease (COVID-19) outbreak as a pandemic and reiterated the call for countries to take immediate actions and scale up response to treat, detect and reduce transmission to save people’s lives [21]. Globally, on 14 March 2022, there have been 456,797,217 confirmed cases of COVID-19, including 6,043,094 deaths, reported to WHO [22]. This virus is part of a diverse family of viruses, consisting of four viral genera (alpha-, beta-, gamma-, and delta-coronaviruses). They infect different body systems of human and vertebrates like the respiratory, central nervous, hepatic, and gastrointestinal systems.

Coronavirus virions are spherical, enveloped virus particles, ranging from 80 to 160 nm in diameter. Prominent surface projections of up to 20 nm in length cover the entire virion surface, giving it the corona appearance. In some species of coronavirus, e. g. TCV, smaller spikes are also seen on the virion surface. Inside the envelope resides a helical nucleocapsid of 6-8 nm in diameter, which can be released from virus particles by mild treatments. All coronavirus virion particles contain three to four structural proteins shown in fig.5 .

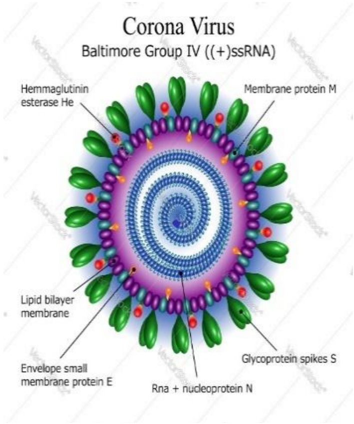

Fig.5: Image of corona virus structure

When a person is infected the most common symptoms include cough, fever and shortness of breath. COVID-2019 transmission occurs person-to-person, either through direct transmission by sneeze, cough, or droplet inhalation, or contact transmission such as ocular contact or through mucous membranes of the eyes and nose and saliva [23].

Therefore, to detect various disease new technologies advancement are necessary. Conventional viral detection methods include an enzyme-based antibody assay and a polymerase chain reaction (PCR) based qualitative assay, viral separation, and immunofluorescence based on microscopy, which is not suitable for repetitive clinical testing. These techniques necessitate a long turnaround time (2 to 14 days), which is inadequate for combatting rapid community spread. The costs of current viral detection tests are also high. Therefore, fast, accurate and reliable method is required. Many time false positive sample cause unnecessary delay in the procedure. Optical based biosensors hold considerable promise as an alternate analytical tool to the existing methods for viral detection, which can help provide timely detection and intervention.

ROLE OF OPTICAL ENGINEERING IN DETECTION PROCESS

In recent years Optical engineering plays an important role in the field of virus detection. This technology provide fast and accurate results. To detect various viruses many types of Optical based biosensors have been developed in recent years these includes: surface plasmon resonance, interferometers, ring-resonators, photonic crystals, fiber-optics , and planar optical waveguides etc.. Optical biosensors are known to be extremely sensitive and can offer ultra-low detection levels, a linear output, low-power consumption, and high resolution [24].

Optical biosensors offer great advantages over conventional analytical techniques because they enable the direct, real-time and label-free detection of many biological and chemical substances. In label free detection the target is not labeled and its functionality is not altered. Therefore it can interact with the analyte naturally. This technique is based on the refractive index change instead of the sample mass. The advantages of optical biosensors are high specificity, fast detection, high sensitivity, real-time monitoring, small size and cost-effectiveness. Furthermore, they offer excellent repeatability, accuracy, and the ability to be miniaturized.

An optical biosensor is a compact analytical device containing a biorecognition sensing element integrated with an optical transducer system shown in fig.6. Optical biosensor produces a signal which is proportionate to the concentration of a measured analyte. Biorecognition elements includes like: enzymes, antibodies, antigens, receptors, nucleic acids, whole cells and tissues.

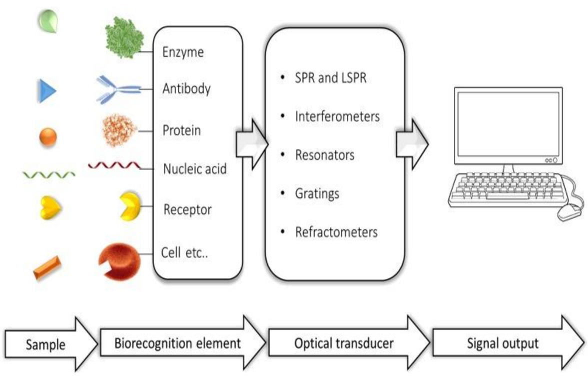

Fig.6: Optical biosensors [7]

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These optical devices can be exploited for light absorption, reflectance, fluorescence, Raman scattering (RS), and refractive index (RI) changes on an optical transducer surface that is known to occur due to specific biomolecular interactions. Optical biosensors offer fast detection, high sensitivity, real-time monitoring, and high-frequency quantification without any time-consuming steps prior to the sample pretreatment steps. In this section we will discuss about the various types of optical technology based biosensors.

1. Surface plasmon resonance (SPR) biosensor: It is an optical technology which provides a label-free and highly specific detection of biomolecular interactions in real-time basis. It detects the change in refractive index (R.I.) when the molecular interaction occurs between antigen and antibody. SPR is the basis of many standard tools for measuring adsorption of material onto planar metal (typically gold or silver) surfaces or onto the surface of metal nanoparticles. It is the fundamental principle behind many color-based biosensor applications, different lab-on-a-chip sensors and diatom photosynthesis [25].

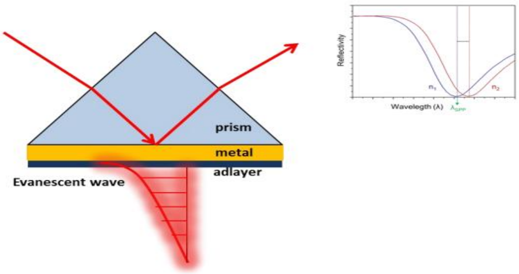

Fig.7: Image of SPR biosensor

When a polarized light falls on a metallic film which containing a range of incident angles, the incident light generates an evanescent field which penetrates into the metal film. The evanescent wave interacts with and it is absorbed by the free electrons cloud that results in a reduction in the intensity of reflected light at the resonant incident angle and wavelength. SPR have been used to enhance the surface sensitivity of several spectroscopic measurements including fluorescence, Raman scattering, and second-harmonic generation.

Nowadays, LSPR-based sensing platforms are considered to be the next-generation plasmonic label-free methods. Current commercialized SPR instruments, such as the well-known Biacore™ series, are expensive and bulky, which limits the extent of their application. LSPR-based detection is more easily miniaturized to increase throughput of detection and reduce operational costs. Characteristics required for state-of-the-art analytical devices, such as LSPR-based portable screening tools, are robustness, sensitivity, specificity and low cost of production [26].

2. Interferometric Biosensors: It is one of the most label free sensitive biosensor in which, the incoming light beam from the source is divided in two beams that travel through different optical paths. In this method one of the light wave is interacting with the sample is acts as a sensing arm and the other one acts as a reference arm.

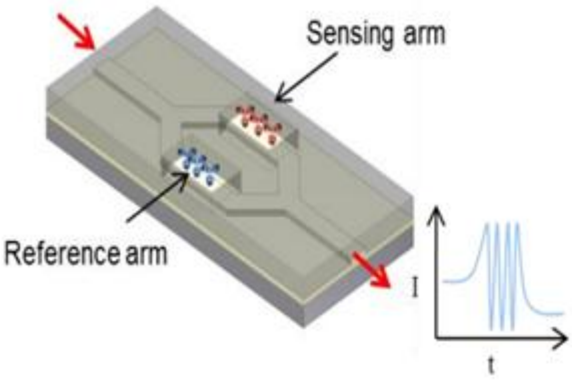

Fig.8: Image of interferometric biosensor based on MZI [28]

The evanescent field of the propagated mode in the sensing arm interacts with the sample. The change introduced in the interference pattern, generated by the recombination of the propagated modes of each path, is proportional to any refractive index variation taking place in the evanescent field of the sensing arm. There are many different structures for interferometric devices which includes Mach-Zehnder Interferometers (MZI), Hartman and Young Interferometers, Biomodal waveguide Interferometer (BiMW).

3. Optical Resonator-Based Biosensors: Optical resonator or optical cavity is an arrangements of optical components which allow a beam of light to circulate in a closed path. This sensor is designed to allow light waves at specific resonant frequencies to be confined and stored within. Light waves continuously travel back-and-forth in between two or more interfaces or circulate within the optical resonator structure.

In optical resonator two types of modes are standing wave resonator and the travelling wave resonator. The travelling wave resonator is also referred to as the ring resonator. In standing wave resonator, the light waves differ in their frequencies but in ring resonator, the light waves differ on both frequency and intensity pattern.

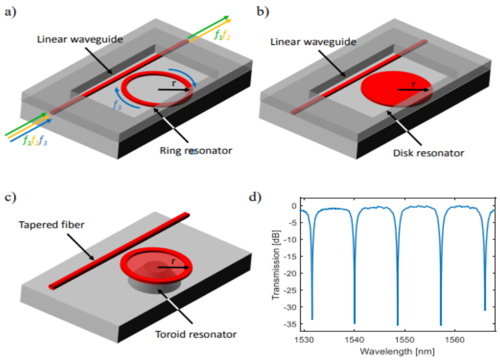

Fig.9: Planar resonant microcavity biosensors [28]

Light waves at a resonant frequency constructively interfere without suffering significant losses, while light waves at other frequencies are suppressed with destructive interference. The resonant frequencies are determined by the material and geometry of the optical resonator. They are highly sensitive to changes in the temperature, pressure, and refractive index of the surrounding medium. The sensitivity of this kind of sensor is related to the sharpness of the resonance response, which is expressed as the quality factor (Q-factor) of an optical resonator.

The Q-factor is defined as

$Q = \omega_0 / \Delta\omega = \lambda_0 / \Delta\lambda$

where λ_0 is the resonant frequency and $\Delta\lambda$ is the full width at half maximum (FWHM) at the resonant frequency. For a specific resonant frequency, the Q-factor increases as the width of the resonant curve is reduced.

For an optical resonator to be used as a biosensor, a bio-recognition element or a bioreceptor, which has an analyte in a biological sample fluid, is functionalized onto it. As the target analytes in a sample fluid attach to the bioreceptor, the effective refractive index of the surrounding medium is changed, resulting in a shift in the resonant spectrum. Either a shift in the resonant wavelength or a change in light intensity is measured with a readout element to quantify the concentration of the analyte in a sample medium and determine the binding kinetics from real-time detection data [27].
Two measures, sensitivity and limit of detection (LOD), are commonly used to determine the quality of an optical resonator-based biosensor. The sensitivity (S) of an optical resonator-based biosensor is the ratio of minimum shift in resonance wavelength ($\Delta\lambda$) to the change in R.I. (referactive index) of material (Δn) is expressed as:

S (sensitivity) = $\Delta\lambda / \Delta n$

Limit of detection (LOD) is calculated using smallest possible spectral shift in the resonant wavelength of sensor due to external or internal effects and sensitivity of that sensor. The LOD is estimated using standard deviation (σ)

Limit of detection (LOD) = $3 \times \sigma$

4. Photonic biosensors: Recently, the use of photonic crystals for the design of biosensors in a variety of ways and use in medical applications is one of the most sought after in today's era. This is a new and accurate measurement technology for bio-sensing applications. Photonic based bio sensor is new research direction in optical field. Many developments have been made in biosensor device in which photonic based biosensor is one of them. Photonic biosensor are presents early diagnostic tool and provide a superior sensitivity, reliability, stability, fast response in vivo and vitro diagnostics. Photonic crystal is natural material and the periodicity of material is maintaining different background material. It is a periodic dielectric structure with lattice parameter based on order of wavelength of propagated electromagnetic wave. One of very important characteristics of photonic crystal is its light confinement and controlling property. These characteristics allowed the crystal to use in various sensing applications.

A photonic crystal (PhC) waveguide consists of periodically repeating arrays of dielectric structures, forming periodic variations in the refractive index. The periodicity is on the order of the optical wavelength and stops a range of wavelengths propagating through the PhC, resulting in a photonic bandgap on the transmission spectrum presented in fig.10. By introducing a defect into the PhC structure, a defect mode at a particular wavelength is formed and resonantly confined in the defect region, which leads to a sharp peak within the bandgap. Due to the strong optical confinement, light is concentrated in a minimal volume near the defect, enabling an intense light–matter interaction area. A tiny volume of analytes immobilized surrounding the defect can induce a noticeable shift of the resonance wavelength and provide a measurable response. Hence, in the past ten years, PhC based biosensors are regarded as a promising and novel technology that has gained much attention [28].

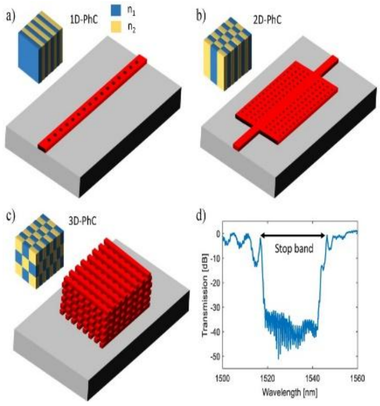

Fig.10: llustration of photonic crystals in: (a) 1D conformation; (b) 2D conformation; and (c) 3D conformation [28].

Therefore photonics crystal based biosensors are excellent sensors for continuous and quantitative label-free biosensing applications. In which direct respond to interactions between analyte and receptor molecules in real-time basis. The photonics crystal are available in one-dimensional (1D), two-dimensional (2D) or three-dimensional (3D).

RECENT ADVANCEMENT AND DEVELOPMENT

1. Recently IIT-Delhi has developed a new handheld device for "early and rapid" detection of dengue disease. This device provides dengue results within the hour. This ultrasensitive and handy device has a wide range of applications in the early-stage on-site detection of viral diseases and can produce the final report of investigation within an hour [29].

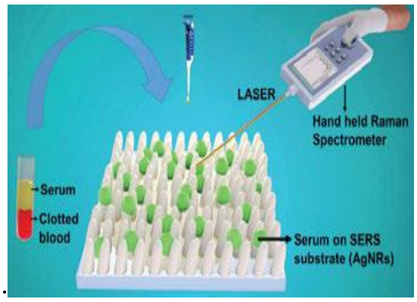

Fig.11: Schematic representation of the handheld SERS platform for early stage detection of Dengue and HIV-1 virus. Credit: IIT-Delhi [29]

2. This fig.12 shows the detection of influenza virus using Qdot-aptamer conjugates and 3D nanoporous photonic crystal. Quenched Qdot-aptamer conjugates are loaded into aerosol spray and photonics crystal is in 'off' stage (shown in fig.12.a). Now virus is captured on the photonics crystal triggering 'on' state (shown in fig.12.b). Finally the signal is detected and measured using smartphone (shown in fig.12.c) [8].

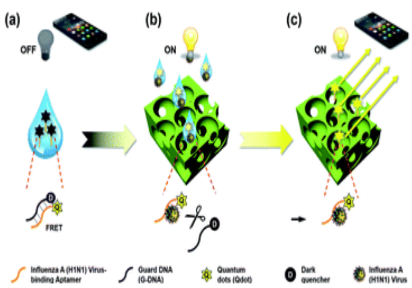

Fig. 12: The proposed "OFF–ON" detection principle using Qdot-aptamer conjugates and 3D nanoporous photonic crystal.

3. Researchers from the University of Twente has developed a Chip-Based Optical Sensor Detects Cancer Biomarker in Urine. This sensor uses laser to detect low levels of a cancer protein biomarker in a urine sample. This technology is

more sensitive, label free detection with less time. This is inexpensive methods of detecting molecules that indicate the presence or progression of a disease [30].

In this sensor the light coupled to the device produced lasing in a microring resonator. The surface of the ring resonator holds probes that capture the analytes of interest. The laser light in the ring extends into the fluid. When an analytes attach to the capture probes, this is sensed by the field outside the microring laser, shifting the frequency of the laser emission. The frequency shift is observed by the detector at the output.

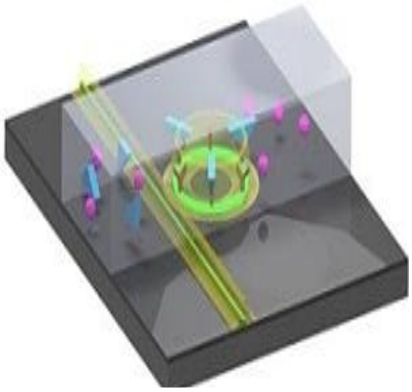

Fig.13: *Chip-Based Optical Sensor Detects Cancer Biomarker in Urine*. Courtesy of Rick Seubers, Optical Sciences group at the University of Twente.

4. Recently, during COVID-19 pandemic, the team of professor Jing Wang, who leads the Air Quality and Particle Technology group at ETH Zurich and a group at the Swiss Federal Laboratories for Materials Science and Technology (Empa), has developed an alternative test method which is based on an optical biosensor that uses thermal and optical method to detect coronavirus [31].

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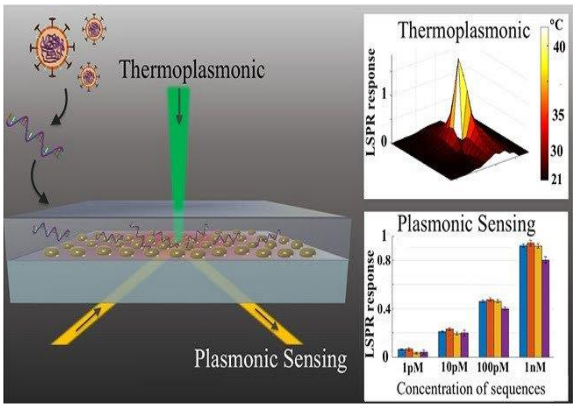

Fig.14: The sensor uses an optical and a thermal effect to detect the COVID-19 virus safely and reliably. Courtesy of American Chemical Society/doi:10.1021/acs.nano.0c02439.

This dual-functional plasmonic biosensor uses the thermal method (plasmonic photothermal-PPT) and optical method (localized surface plasmon resonance-LSPR) for detection. It combines with both methods (PPT and LSPR) on a tiny, 2D, gold nanoisland (AuNI chip), which is on a glass substrate. This new diagnostic method provides fast and accurate results.

CONCLUSION

As the population are increasing day by day include the increasing prevalence of various target diseases such as dengue, cancer, COVID-19 virus, influenza etc. Recent example of COVID-19 outbreak worldwide. Thus, increasing demand for inexpensive and reliable tool, biosensors are in demand. During this COVID-19 situation, viruses are affecting lots of people and also continue to create significant health problems. To detect various disease conventional diagnostic method like RT-PCR (Reverse Transcriptase Polymerase Chain Reaction) is used but this method is time consuming process and this technique requires expensive equipment and reagents for the diagnosis purpose. Therefore, for early and fast detection of various disease development of new technologies are required. Optical technology is one of the most promising approach to satisfy the growing demand for effective medical diagnostic technologies. Optical based biosensors are provide the fast and accurate result. This is having many advantages like fast, reliable, sensitive, small in size, low power consumption etc. In this paper we have discussed that how many types of virological diseases affect the people life. We have discussed about some deadly disease caused by the viruses like cancer, dengue, influenza virus, COVID-19 in this paper. We have also discussed that how the optical technology help for early diagnosis with fast and accurate result without consuming long time. In optical technology optical based biosensors are in demand nowadays due to their fast detection, high sensitivity, real-time monitoring, and high-frequency quantification without any time-consuming steps prior to the sample pretreatment steps. Therefore we have discussed about some optical based biosensors that help to detect these kind of virological desease. Many researcher has designed various biosensor. Therefore we have studied the review of literature also in this paper. Recently some advancement and development in the field of biosensors also discussed in this paper.

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