The continued development of photonics technology is crucially dependent on the availability of suitable optical materials. Biomaterials are emerging as an important class of materials for producing novel or otherwise improved photonic devices. From the rich world of organic materials, biomaterials are of particular interest as they often have unusual properties that are not easily replicated in conventional organic or inorganic materials in the laboratory. Furthermore, natural biomaterials are a renewable resource and are inherently biodegradable. The most important and famous biomaterial known to man is DNA (Deoxyribonucleic Acid), the polymeric molecule that carries the genetic code in all living organisms. It is clear that the unique structure of DNA results in many optical and electronic properties that are extremely interesting for photonic applications. DNA can be used as a photonic material for making optical waveguide, both on its own and also as a host material accepting appropriate chromophores.

Another application of biomaterials is for the synthesis of nano materials. Synthesis of nanoparticle is an emerging field due to its potential application in catalysis, optical, magnetic and electronic devices. Among biological molecules deoxyribonucleic acid (DNA) and protein bovine serum albumin (BSA) have been used extensively as biotemplates to grow inorganic quantum confined structure and to organize non biological building blocks into extended hybrid materials. Biological macromolecules are capable of controlling nucleation and growth to a remarkable degree through bio- mineralization. DNA template has also been described as a smart glue for assembling nano particles. In general, synthesis of nano particles based on DNA template has been done by incubating metal ion coated DNA in a reduction agent solution. The ion DNA complexes control the release of metal ions, thereby slowing down their reduction and
effectively inhibiting metal ions from growing into big clusters. Nano-structures of metals such as silver, gold, palladium, platinum, copper, and nickel have been successfully synthesized by using DNA network templates.

The nonlinear optical properties of the metal nanoparticles depend on the host material which supports them. A large number of investigations has been carried out to study nonlinear optical properties of metal nano particles dispersed in different optically transparent solid matrices and liquids. However, only limited research has been done on the nonlinear optical property of the metal nanoparticles in bio polymer template.

Research on synthesis of semiconductor nanoparticles having a controlled size distribution has attracted significant interest because of their luminescent properties, quantum size effects and other important size dependent physical and chemical properties. Semiconductor nano crystals are tiny light-emitting particles on the nanometer scale. Researchers have studied the characteristics of these particles extensively and have developed them for broad applications in solar energy conversion, optoelectronic devices, molecular and cellular imaging, and ultra sensitive detection. A major feature of semiconductor nano particles is the quantum confinement effect, which leads to spatial enclosure of the electronic charge carriers within the nanocrystal. For instance, the band gap emission can be tunable over wide wavelengths by adjusting an appropriate size of the particle. The particles prepared from such viewpoint should be useful as a fluorescence agent for optical and biotechnological applications.

Laser Induced Fluorescence has proven to be a versatile tool for a myriad of applications. It is a powerful technique for studying molecular interactions in analytical chemistry, biochemistry, cell biology, physiology, nephrology, cardiology, photochemistry, and environmental science. As the theoretical underpinnings of fluorescence became more understood, a more powerful set of
applications emerged that yield detailed information about complex molecules and their reaction pathways. Measuring of fluorescence quantum efficiency is one of the experimental techniques to characterize biological samples.

A detailed investigation will be presented in the present thesis related to direct applications of biopolymers into some selected area of photonics and how the growth kinetics of an aerial bacterial colony on solid agar media was studied using laser induced fluorescence technique.

In chapter 1, an overview of various biomaterials and their application to photonics are presented. A wide range of photonics applications using biomaterials include efficient harvesting of solar energy, low-threshold lasing, high-density data storage, optical switching, filtering and template for nano structures. The chapter discusses these applications of biomaterials briefly. The most extensively investigated photonics applications in biology is Laser induced fluorescence technique. The importance of fluorescence studies in different biological and related fields and are also mentioned in this chapter.

Chapter 2 describes the effect of DNA on nonlinear optical properties of Rhodamine 6G-PVA solution through open aperture Z-scan. Saturable absorption (SA) at 532nm was observed for dye solution without DNA. A strong influence on SA behavior of dye solution was observed by adding DNA. As the concentration of DNA is increased, we observed RSA within SA. Theoretical analysis has been performed using a model based on nonlinear absorption coefficient and saturation intensity.

In chapter 3 we present results of investigation on the influence of DNA on amplified spontaneous emission of Rhodamine 6G –PVA solution and thin film. The presence of DNA reduces the threshold value of lasing and full width half maximum of fluorescence spectra. Thin solid film of DNA has been fabricated by treating with polyvinyl alcohol (PVA) and used as host for the
laser dye Rhodamine 6G. The edge emitted spectrum clearly indicated the existence of laser modes and amplified spontaneous emission (ASE).

Studies on nanoparticle synthesis using DNA is the subject matter of **chapter 4**. Highly stable silver nanoparticles in aqueous solution at room temperature is synthesized by standard reduction method using DNA as stabilizing agent. The linear and nonlinear optical properties of silver nanoparticles at different concentration of DNA is studied. Absorption spectra shows the Ag plasmon resonance lies around 410 nm and silver nano-particles formed in higher concentration is less. The nonlinear absorption coefficient $\beta$ and imaginary part of third order susceptibility depends on the concentration of DNA at low pump power. It is observed that at high pump power, the nonlinear absorption coefficient ($\beta$) and imaginary part of third order susceptibility does not depend on the concentration of the DNA. The imaginary parts of third order nonlinear optical susceptibility measured by Z-scan technique revealed that silver nano particle synthesized in aqueous solution of DNA have good nonlinear optical response and could be chosen as ideal candidate with potential applications for nonlinear optics. The nonlinear absorption of silver nanoparticles at high intensity is attributed to the influence of DNA on nanoparticles. We also studied photo luminescence of silver nanoparticles at different concentration of DNA. It is observed that the emission of silver nanoparticles is getting enhanced as concentration of DNA increases.

In **chapter 5** describes the work related to the synthesis of silver nano particles using bovine serum albumin (BSA) biopolymer. Highly stable silver nano particles in aqueous solution at room temperature is synthesized by standard reduction method using BSA as a stabilizing agent. Prepared solution shows strong absorption peak originating from the surface plasmon absorption of nanosized silver particles in aqueous solution of BSA. The photo
luminescence spectra show emission peak at 538 nm at excitation wavelength 250 nm. The nonlinear optical properties were investigated by a single beam Z-scan setup. The nanosol show an excellent nonlinear optical property. Silver nanoparticle in BSA template is a potential candidate for optoelectronic device applications.

Chapter 6 discusses band gap tunability of CdS nanoparticles in biotemplates DNA and BSA. DNA is more efficient in controlling the size of the nanoparticles. Since nanoparticles are capped with biomaterials, they were very useful for biolabeling. We have studied excitation wavelength dependence on fluorescence emission of CdS nanoparticles stabilized with DNA and BSA. Excitation wavelength changed from 260 nm to 480 nm.

Chapter 7 discusses laser induced fluorescence technique, which has been used for studying growth dynamics of an aerial gram positive bacterial colony on nutrient agar medium. This technique has been shown to be a useful technique for obtaining information about the different growth phase of the bacterial colony. Quenching effect of dye by bacterial colony can be effectively used to analyze growth kinetics of bacterial colony. Quenching effect of fluorescence indicates that cultured bacteria were gram positive. The rate of quenching of fluorescence of dye from bacterial colony was proportional to rate of increase in area of the bacterial colony which in turn indicates that the rate of quenching of the fluorescence was proportional to rate of growth of bacteria.

General conclusions drawn from the studies and further areas in which the work can be extended are discussed in chapter 8.
LIST OF PUBLICATIONS

A. Journal Publications:


8. Rose Leena Thomas, Vasuja, Misha Haril, **B. Nithyaja** S. Mathew, I. Rejeena, Sheenu Thomas , V. P. N. Nampoori and P. Radhakrishnan;

B) Conference Papers:


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