Glasses are nonequilibrium amorphous solids which play a prominent role in the technology. It came to limelight as functional materials since the development of optoelectronic devices and nano-lithography. The compositional flexibility and macroscopic homogeneity of glasses boosts its scientific and industrial interest. But the fast crystallization/ recrystallization, physical instability etc. limits the glasses from its practical applications. Recently, a new method to produce glasses with very high stability was introduced: 'the vapor deposition technique'. The ultra-stable glasses, which are made by the vapor deposition technique could draw wide attention of the scientific community as they could overcome the instability in organic glasses, which was one of the major limitation for its technological applications. In contrast to the conventionally cooled liquids which can take thousands of years to form a stable glass, the vapor deposited glasses are known to produce energetically stable, highly dense materials that can resist crystallization as well as the water uptake. Despite the enormous amount of work done in past few decades, an apparent understanding of the glass formation and an adequate control over its properties still remain intractable. The same research gap exists in case of vapor deposited glasses as well. Apart from its practical applications, it is also an interesting theme to delve deep into the fundamental issues such as the Kauzmann entropy paradox. In this work, the main aim is to '*understand the interfacial interactions involved in the ultrastable glasses (USG) under geometric confinement; leading to the development of novel ultrastable glasses for practical applications*'. Initially we will investigate the properties of USGs under geometric confinement. This results in turn will help to develop crystallization resistant, high density materials for practical applications.

Another important research theme addressed in this research is the '*refractive index engineering using multilayer polymer nanocomposites'*. Since the energy crisis of 1970's, the world has been looking towards better light sources and Light Emitting Diode (LED) was the answer. Increased demand for energy efficient lighting has led to the wider adoption of LEDs and the LED industry thrives towards attaining higher efficiency. Reducing the refractive index mismatch between the semiconductor used in the LED and the LED encapsulant increases the light extraction from the Light Emitting Diode. The use of graded refractive index materials is a solution for this problem. Polymer nanocomposites (PNCs) are desired candidates for such applications due to their remarkable properties compared to conventional composites and pure polymers. One of the major challenges while designing such materials for a specific application is to tune the interfacial properties of modified surfaces, which can have a significant control over the overall behavior of the system. Here we plan to develop multi-layer polymer nanocomposites, as the multilayering can help to have multiple RI values in the same film with very good flexibility and light extraction efficiency. Apart from LEDs, this is very useful for applications such as in couplers, micro lenses, waveguides etc. as well. In order obtain such films, PNCs of different refractive index will be made and they will be stacked one over the other to form the desired optical characteristics. This will involve overcoming multiple hurdles like the dispersion of nanoparticles in the polymer matrix, successful multilayer film formation, tuning the refractive index of individual PNCs as well as multilayers etc.

Thus the proposed research will address various poorly under stood/ hot debated topics under nanoconfinement, and that too for novel, hybrid materials like ultra-stable glasses as well as multilayer polymer nanocomposites, which are highly sought after research topics. Apart from fundamental research, this work will contribute towards numerous practical applications and industrial implementations as well. It can bring about the development of high density molecular glasses, stable glasses under geometric confinement, multi-layer polymer nanocomposites with tunable refractive index, crystallization resistant molecular drugs etc.