The technological advancement of bandgap engineering through alloying of semiconductor materials has opened up for wide applications in optoelectronics. From the early 90's research on wurtzite ZnO as an alternative to the GaN system has started and still is going on because of its wide direct band gap of 3.37 eV and large exciton energy of 60 meV which is higher than GaN (binding energy 25 meV). The rise in research not only about the basic properties of ZnO but also on the related group II-VI semiconductor oxides like MgO and CdO which can be combined to form heteroepitaxial device structure. Many studies over the past decade have explored related to ZnO-CdO and ZnO-MgO systems. However, despite having the same crystal structure of both CdO and MgO (cubic rocksalt structure; $Fm\bar{3}m$), the phase separation at the equilibrium condition is a challenging topic and it has not been explored properly. Furthermore, to date there is no device has been developed based on the CdO-MgO system. Thus the question of the development and introduction of new types of CdO-MgO based heterostructures is relevant. Again, the bandgap tunability of CdO from 2.3 to 7.5 eV, by alloying with MgO increases the perspective applications for CdO-MgO based heterostructures as it enables light emission over UV to the visible regime which allows quantum wells and energy barriers formation to provide significant quantum efficiency and effective quantum confinement.

In this project, we will adopt plasma-assisted molecular beam epitaxy (PA-MBE), the non-equilibrium growth technique. We plan the growth on various substrates (like $Al_2O_3$, Si, Quartz, and ZnTe). This high vacuum growth technique will allow us to grow CdO-MgO based heterostructures with low densities of defects and low impurities levels which are typically required for optimum semiconductor device performance. Along with structural and electrical characterization, pressure and temperature-dependent bandgap studies might also be beneficial in order to get a good understanding of the parameters of the grown heterostructures. I expect my results will guide further development of diodes and sensors which can be used for potential applications for deep UV light emission and /or detection.

The main objectives of this project include:

1) Growth of CdO-MgO based heterostructures (including ternary alloys and QW structures) using plasma-assisted MBE technique. Optimize the growth process by focusing on the influence of doping concentration along with growth parameters like growth temperature, control of fluxes, growth time, pressure, etc. to obtain high-quality alloys and heterostructures.
2) Exploration of properties of CdO-MgO based heterostructures, by means of structural, morphological, optical, and electrical characterizations. Detail investigations of the absorption behavior at different conditions such as; temperature and pressure-dependent studies.
3) Formation of junctions and diodes using the growth heterostructures which has potential application for the detection of deep UV (UVC) radiation.

The use of advanced methods and unique research equipment available to the group applying will allow for a deep understanding of CdO-MgO heterostructures properties and opens up new prospects for the design of novel optoelectronic devices.