**Applications:**

**Introduction:**

ZnO is a (II–VI) compound semiconductor with a wide direct band gap of 3.37 eV and a large exciton binding energy of 60 meV at room temperature, which makes it a promising candidate for highly efficient, ultraviolet-light-emitting diodes and ultraviolet lasers. Due to its piezoelectric properties, ZnO is being explored for fabricating various pressure transducers and acoustic wave and optoacoustic devices. ZnO is also one of the promising materials for applications in transparent conductors, thin-film transistors, varistors, catalysts, gas sensors and solar cells. When the ZnO is doped with external or foreign dopants, the range of applications of these doped ZnO is extended for the enhanced characteristics and modifications of several parameters of properties [12].

**Transparent Conducting Oxides:**

There are several good combinations of properties are observed in Zinc Oxide semiconductor materials, such as optical transparency at visible wavelengths, have satisfactory values of band-gap (direct and wide bandgap at room temperature). These semiconductors also show large exciton binding energy (about 60 Mev at room temperature). These properties make it suitable for many optoelectronics applications [1]. For TCO materials, both electrical conductivity and optical transparency should be properly maintained by perfect doping. Some of the materials like B-, Al-, Ga-, In-, and F- has already shown good properties for TCO (Low resistivity and high optical transparency) [2-4].

**Solar Cells:**

As the TCO materials are used by ZnO based semiconductors. The ZnO always show n-type conductivity due its off- stoichiometry. For this reason, it is imposed native defects, like oxygen vacancies (VO) and zinc interstitials (Zni). Thes defects create donor states within the forbidden band gap. But it is necessary to increase more for some specific purposes without the degradation of optical transparency, which can be achieved by dopants. In this case, group (iii) are more efficient as dopants such as Al, B etc. [5].

**Gas Sensors:**

Gas sensors based on various metal oxide semiconductors (MOS), such as SnO2, ZnO, TiO2, WO3, In2O3 , copper oxides, MoO3, Nb2O5 and so on, have been extensively studied due to their significant resistance change upon exposure to a trace concentration of toxic or flammable gas. Among these MOS, ZnO is considered as one of the most promising gas sensing materials for its high chemical and thermal stability, low cost, fast response and flexibility in synthesis [6].

**LEDs:**

Zinc oxide (ZnO) is an attractive candidate for UV light emission since it is an environmentally friendly material which can be grown at low temperatures on cheap transparent substrates and has both a direct wide band gap of 3.3 eV and a very large exciton binding energy of 60 meV and important for robust light emission [7,8].

ZnO and related semiconductors are alternatives to GaN based compounds for fabrication of UV/blue light emitting diodes (LEDs). Progress in development of ZnO LEDs has been disappointing due to the difficulty of achieving robust p-type doping and the low crystal quality of heterojunctions and quantum wells [9].

**Transistors:**

The potential for flexible, lightweight, mechanically robust electronics for displays and other devices on plastic substrates has motivated considerable research on new materials and improved processes for fabricating thin film transistors (TFTs).

A stable inorganic semiconductor compatible with temperature sensitive substrates, and with electronic properties equivalent to amorphous Si would enable electronics on a variety of flexible substrates. It is contended that a ZnO semiconductor can meet those requirements [10].

**Varistors:**

ZnO powders are very important materials due to many interesting properties inherent in this material, such as dielectric, piezoelectric, pyroelectric, semiconducting etc.

Moreover, ZnO ceramics containing several metal oxides, such as Cr2O3, Bi2O3, Sb2O3, Co3O4, MnO2 etc., show highly nonlinear current-voltage characteristics which enables them to be used as protection devices against voltage surges and voltage transients. The varistor effects take place at the grain boundaries within the ceramics and numerous theories have been developed to explain the effect. It is necessary to have homogeneous distribution of dopants and the correct oxygen concentration to form good varistor ceramics [11].

There are vast applications in the thin film technology, which can be deposited from different phases like vapor, liquid, gas or solid phase. Here, some applications are given below [13]-

Applications of Thin Films

|  |  |
| --- | --- |
| **Engineering and processing** | Protective layers and low friction coatings to reduce wear, corrosion and erosion; high temperature corrosion; surface passivation; decorative coatings; catalytic coatings |
| **Optoelectronics** | Photodetectors; liquid crystal display (LCD); TFT; optical memories; light amplification by stimulated emission of radiation (laser); LED |
| **Optics** | Integrated optics; anti-reflex and high reflecting coatings (laser mirrors, interference filters, mirrors); beam splitter; thin film polarizer. |
| **Electronics** | Integrated optics; anti-reflex and high reflecting coatings (laser mirrors, interference filters, mirrors); beam splitter; thin film polarizer. |
| **Cryotechnics** | Superconducting quantum interference devices (SQUIDS); superconducting thin films; switches; memories |
| **Optoelectronics** | Gas sensor; biosensors |