ABSTRACT

The studies of semiconductor thin films and their junctions such as metal semiconductor junctions (Schottky Barriers) have received much attention due to their applications in various electronic and optoelectronic devices including high frequency switching device, Schottky barrier devices, solar cells etc. But, realization of any electronic device using a combination of bulk and thin film or all bulk or all thin film components essentially requires metallization of metal contacts for electrical signals to flow into and out of the device. Thus junction between two metals and metal-semiconductor is an integral part of the device without which communication to the external circuit components would not be possible. In this reference stable metal-semiconductor contacts of ohmic as well as rectifying nature are very much important from technological point of view. In both cases preparation of reliable and efficient metal contacts with high yield and stability is challenging task for devices operating at high frequencies when packing density is increased by many fold. Thus, the behavior of metal-semiconductor contacts at microscopic scale may be explored for the development of future technology.

The subject matter of such contacts is well documented in many books with review of developments in the recent past. Earlier devices were prepared on the bulk elemental semiconductors as an active region which was then followed by crystalline/amorphous compound semiconductors in bulk as well as thin film forms like Solar cells, *p-n* junction diodes, Schottky barrier devices etc. in recent past. Normally bulk crystalline or amorphous substrate is used to support device structure made from crystalline/amorphous bulk and thin film. However, to the best of author's knowledge no attempts have been made to study the devices prepared by depositing semiconductor thin film with thin metal film supported by a by a non-conducting glass substrate.

For this purpose, studies were carried out on structural, optical, electrical properties of $p\mathrm{WSe_2}$ thin film and its applications in thin film Schottky diode.

Tungsten Diselenide (WSe_2) is the sparkling member of Transition Metal Dichalcogenides (TMDC) materials of group *VIA* and *VIB* which have received considerable attention because of its diverse semiconducting properties along with anisotropic characteristics arising from their layered structure, which is widely studied and reported by many scientists in both single crystals and thin film form. Due to its anisotropic natures of X - M - X (where X - chalcogen, M - metal) can be easily cleaved along c - axis which makes it the most potential candidate for flexible electronic devices like Schottky barrier devices, MESFETs, solar cells etc. Looking towards the wide applications reported by many scientists, it was proposed in the present case to study the growth and characterization of tungsten diselenide - WSe_2 in thin film form and its applications in Schottky barrier diode. The results of the studies have been presented in the thesis written in seven chapters.

Chapter 1 begins with the importance of thin films and its possible use in electronic device like Schottky barrier. It also deals with the comprehensive discussion on the importance of transition metal dichalcogenide compound semiconductor (i.e. WSe_2) for the fabrication of different electronic devices. A brief review of research work carried out earlier on WSe_2 along with various techniques used for preparation of WSe_2 films by different workers has been given. Also, a brief review of research attempts on Schottky barriers using bulk and crystalline WSe_2 as a substrate has been given.

Chapter 2 covers the information regarding existing thin film preparation techniques (i.e. Thermal evaporation, flash evaporation and ē - beam evaporation) which could be useful for the deposition of tungsten diselenide thin film. Thin films deposited using these techniques have been characterized by Energy Dispersive Analysis of X-ray (EDAX) and their results are discussed. On the basis of EDAX results, ē - beam evaporation technique has been chosen for further work.

Chapter 3 provides structural and morphological characterizations of deposited thin films of WSe_2 by ē - beam evaporation method. It includes structural characterization by X-ray diffraction and electron diffraction of WSe_2 thin films of various thicknesses. The grain size, planes of reflection, micro strain, dislocation density and lattice parameters have also been optimized using XRD study. Electron diffraction patterns confirm the polycrystalline nature of deposited thin films. Scanning electron microscopy and Atomic Force Microscopy have also been used for morphological study and their important outcomes are discussed in this chapter at the end.

Chapter 4 gives the detailed study of optical absorption as a function of film thickness. This study gives the value of optical bandgap of deposited thin films. It is found that the value of bandgap is decreased with increasing thickness. Various optical parameters like refractive index, extinction coefficient, dielectric constant have also been evaluated and discussed in detail.

Chapter 5 incorporates the study of electrical transport properties of WSe_2 thin films. It includes temperature dependent Hall-Effect measurements and thermoelectric power measurements. From these study the type of deposited thin films, electrical resistivity, carrier concentration and Seebeck coefficient, scattering parameters etc. have been evaluated. The effect of thickness and temperature on electrical transport properties is also described in detail.

Chapter 6 covers the device fabrication and characterization of the prepared devices at different temperatures. Rectifying metal contacts of aluminum with semiconductor thin film of WSe_2 were prepared by thermal evaporation of metal. Ohmic contacts were prepared by Ag - alloy wires and silver paste. The prepared devices then characterized for their Current - Voltage characteristics at low temperatures using the low temperature cryogenic setup coupled with the semiconductor characterization system. From this study various Schottky diode parameters have been optimized and their temperature dependent properties were analyzed in detail. Finally, the role of barrier inhomogeneity in the conduction mechanism is described at the end of this chapter. General conclusions of the present investigations are summarized in **chapter 7** and it ends with the scope for the future work.