Electrical Characteristics of Ge-Ag Semiconductor Diode

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Abstract

The group I element of silver (Ag) was deposited on group IV element of n-type germanium (n-Ge) substrate at various heating temperatures of 700ºC, 800ºC and 900ºC. The metal semiconductor junction is formed. I-V characteristics of Ge-Ag diodes without illumination and with illumination were measured.

Keywords: Ge-Ag diode, germanium, silver, I-V characteristics.

Introduction

Semiconductor devices are small but versatile units that can perform an amazing variety of control functions in electronic equipment. Like other electron devices, they have the ability to control almost instantly the movement of charges of electricity. They are used as rectifiers, sensors (or) detectors, amplifiers, oscillators, electronic switches, mixers, and modulators. In addition, semiconductor devices have many important' advantages over other types of electron devices. They are very small and light in weight. They have no filaments or heaters, and therefore require no heating power or warm-up time. They consume very little power. They are solid in construction, extremely rugged, free from microphonics, and can be made impervious to many severe environmental conditions. The circuits required for their operation are usually simple [Dan S E 2000].

The other electron devices depend for their functioning on the flow of electric charges through a vacuum or a gas. Semiconductor devices make use of the flow of current in a solid. In general, all materials may be classified in three major categories - conductors, semiconductors and insulators. They are depending upon their ability to conduct on electric current A semiconductor material has poorer conductivity than a conductor but better conductivity than an insulator [Puri P K 2003].

The materials most often used in semiconductor devices are germanium and silicon. Germanium has higher electrical conductivity (less resistance to current flow) than silicon and is used in most low and medium power diodes and transistors. The principal desirable features of both germanium a silicon is gallium arsenide [Tyagi M S 2000].

Experimental Procedure

In this research, Ge have been used as substrates. As it is well known that the surface preparation is important in growing ultrathin layer. The deposition of smooth highly perfect film require a polished substrate surface. The preparation of highly polished substrate surface was difficult. Strained surface layers normally prevented the deposition of smooth layers.

For practical contact, the samples are treated with various acidic or base solution before deposition metal layers to reduce contamination. Manufacturing electronic devices use wet chemical etching procedures. These etching procedures are required to get damage free surface, to improve the film qualities, to obtain a stoichiometric surface, to remove native oxide and possible defects.

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The substrate Ge and crucible are cleaned and dried by the following processes. Germanium are chemically etched by etching aquaregia solution to remove carbon and hydrocarbon contamination for 5 min. Immerse in deionized water (DI water) for 5 min. Rinse in DI water for 10 min. Washing in alcohol to remove the remaining DI water for 5 min and Dry the substrates.

Similarly the crucible are cleaned by aquaregia and dry by above procedure. And then the polycrystalline Ge substrate was chemically cleaned in HCI-based solution to remove oxides and leaves less oxygen residue, prior to being placed in the system. The crystalline Ag was deposited on the clean Ge. After cleaning the metal Ag and substrates Ge, Ag powder was placed on the surface the germanium wafer. Those metal Ag and substrate were placed in the crucible altogether. This crucible was placed into the chamber. Silver (Ag) is grown on germanium (Ge) substrates continue to get the appropriate thickness of film under the conditions of normal atmospheric pressure, 700ºC, 800ºC, 900ºC (Furnace Temperature) and for one hour (annealing time). After the deposition of Ge-Ag film, the slice was taken from the furnace and cool down at room temperature.

Results & Discussions

The characterization of a material is an essential part of any investigation, not only the chemical and physical properties, but also its structure. Typically, the structure and symmetry of a solid material governs its observed properties.t Many of the industrial applications of materials make use of their particular electronic and magnetic properties. These properties are often directly related to their physical structure. The idea of metallic conductivity should now be familiar electrons are the change carriers which move through a lattice consisting of metallic ions. The term "metallic conductivity" is somewhat confusing, as this behavior is not limited to metals and alloys.

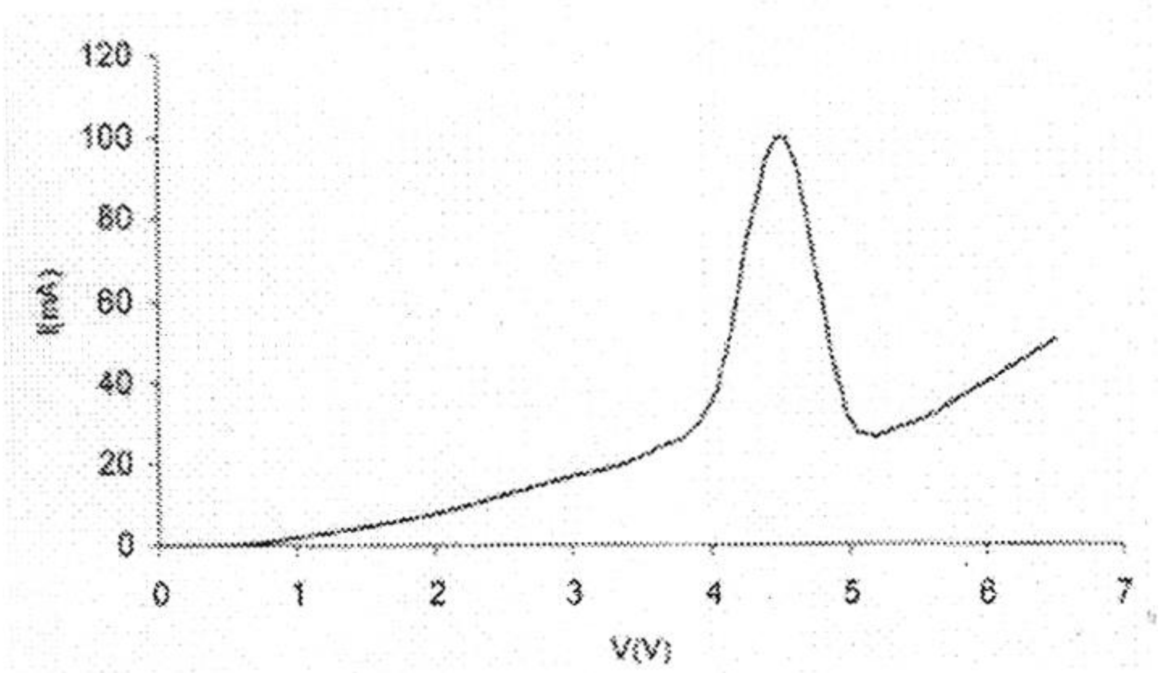

Figure 1. I-V characteristic curve of Ge-Ag diode at 700ºC heating temperature without illumination

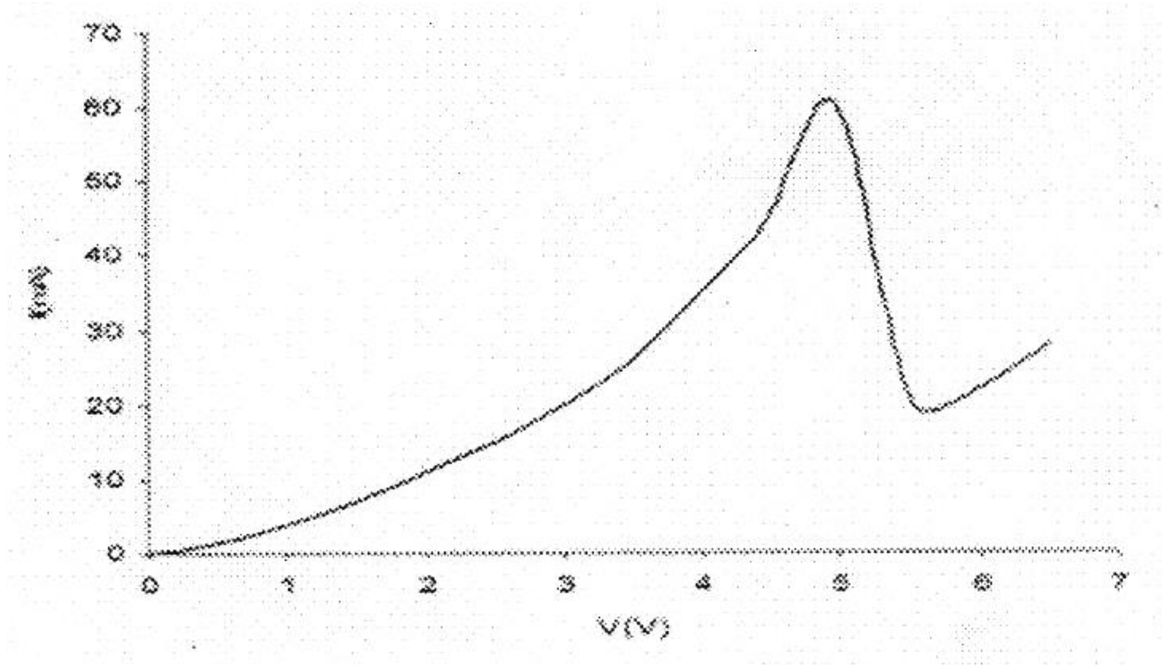

Figure 2. I-V characteristic curve of Ge-Ag diode of 700ºC heating temperature with illumination

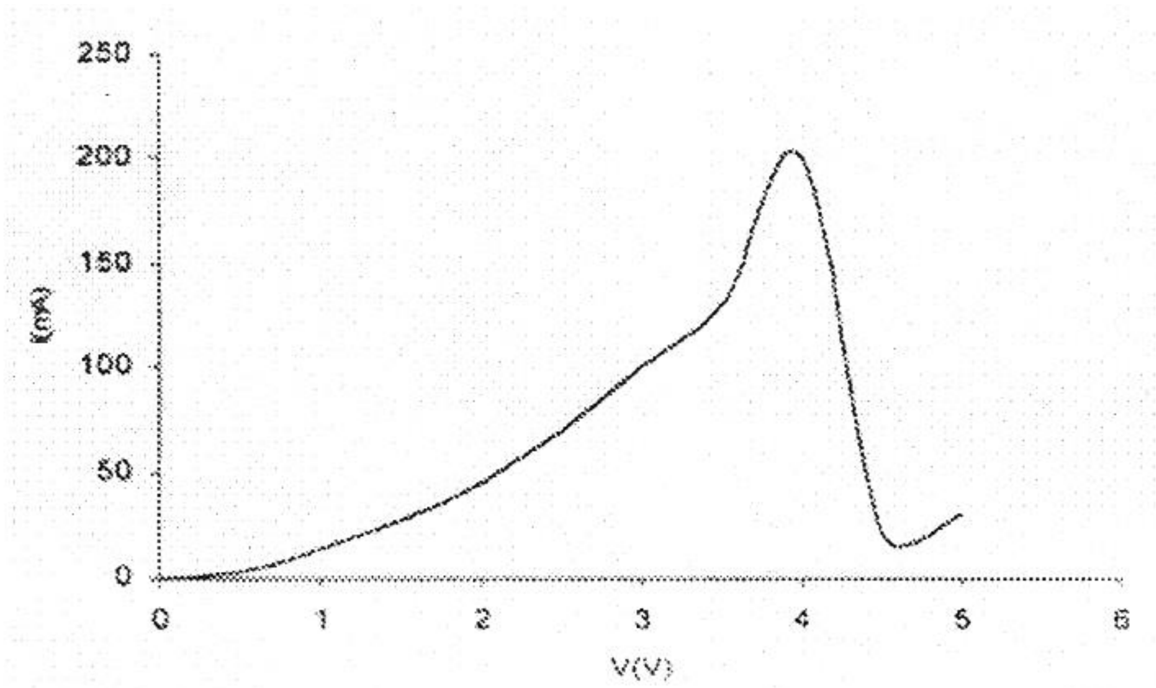

Figure 3. I-V characteristic curve of Ge-Ag diode at 800ºC heating temperature without illumination

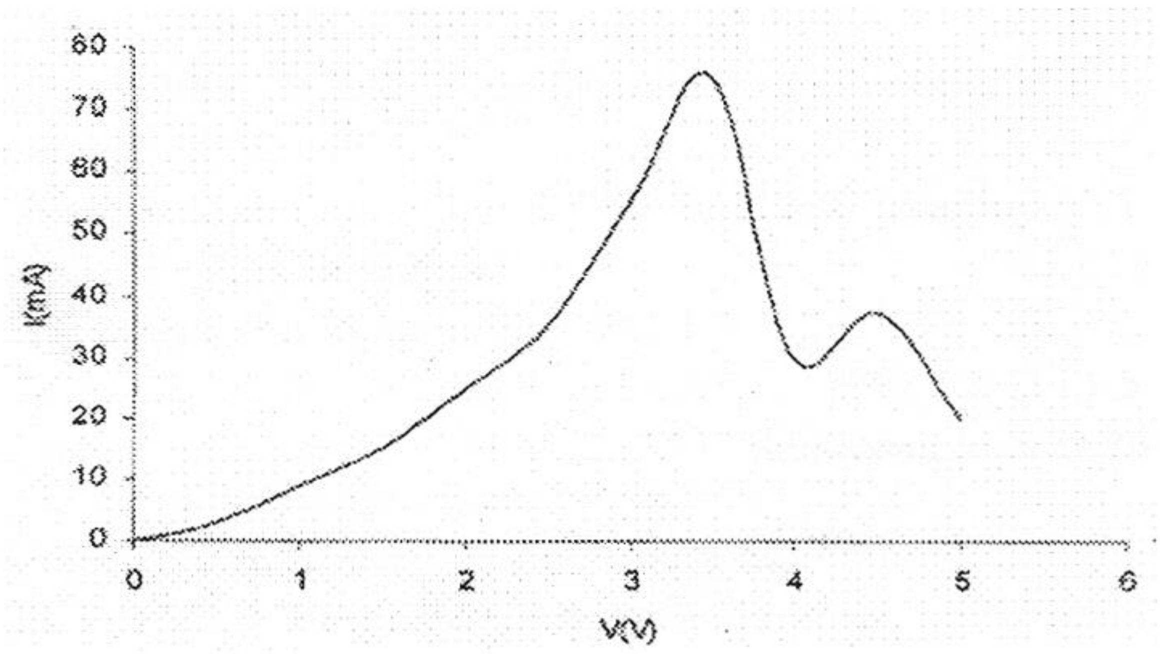

Figure 4. I-V characteristic curve of Ge-Ag diode at 800ºC heating temperature with illumination

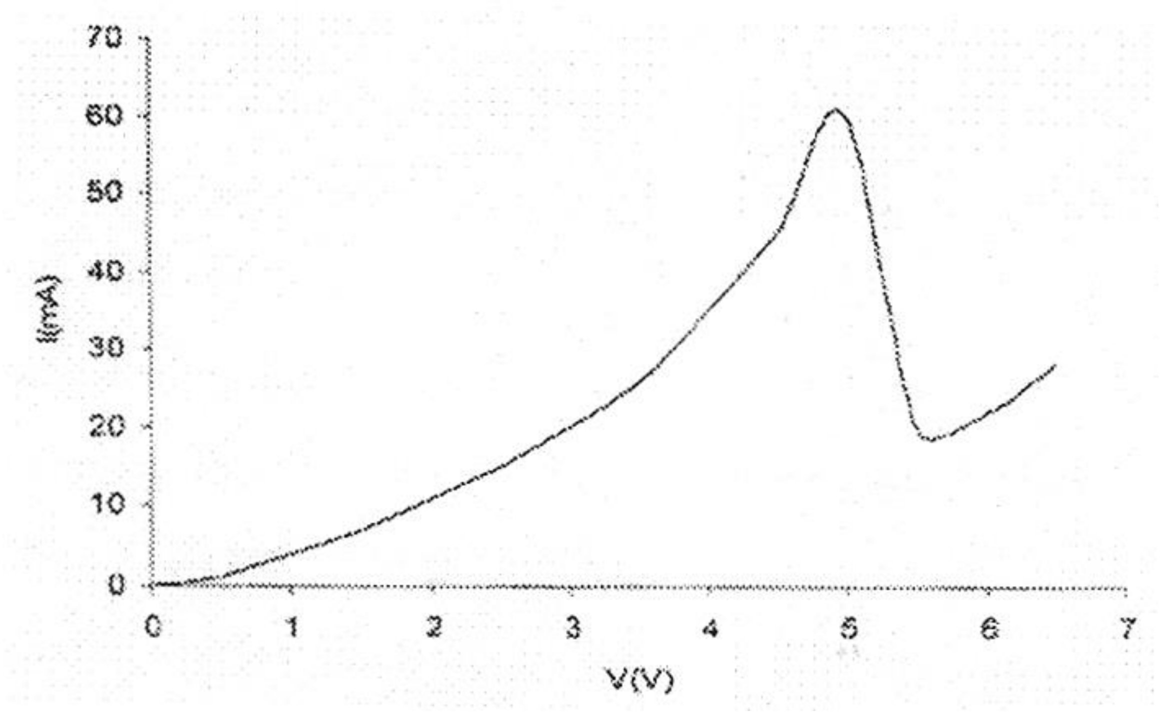

Figure 5. I-V characteristic curve of Ge-Ag diode at 900ºC heating temperature without illumination

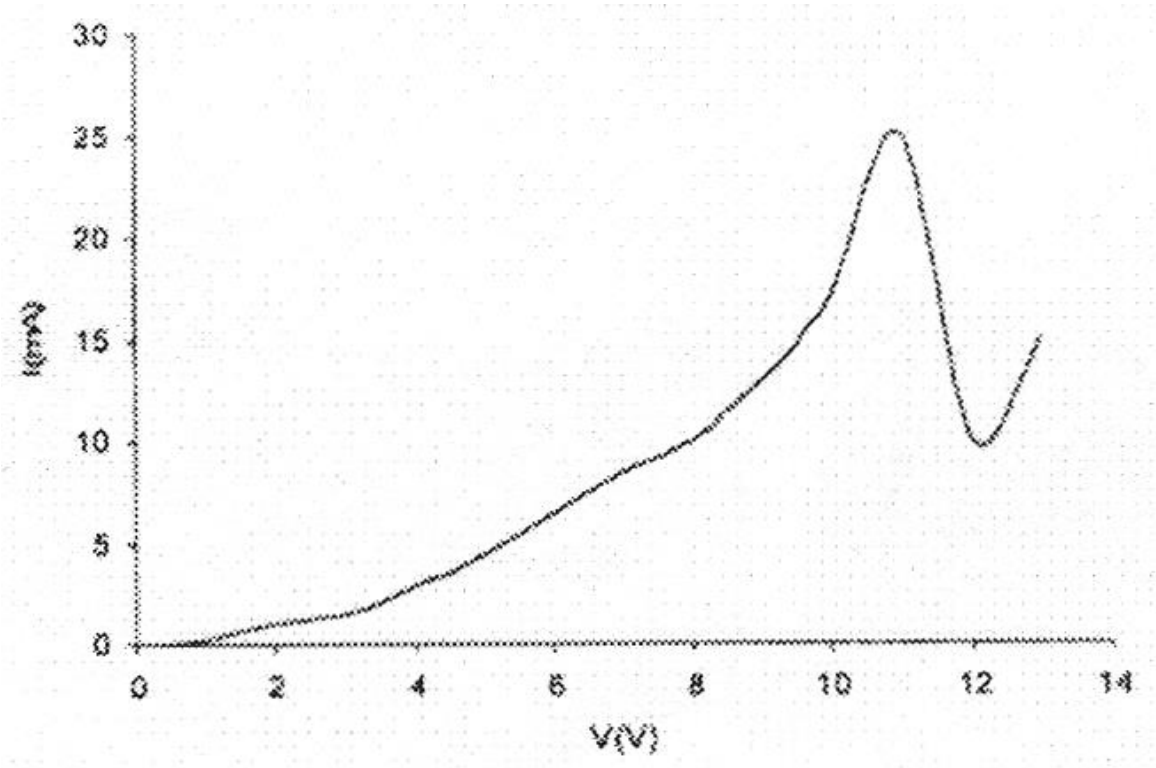

Figure 6. I-V characteristic curve of Ge-Ag diode at 900ºC heating temperature with illumination

Sr. No.	Annealing Temperature (ºC)	Normal Light		88 Lux		320 Lux	
		I_{max} (mA)	V_{max} (mA)	I_{max} (mA)	V_{max} (mA)	I_{max} (mA)	V_{max} (mA)
1	700	100	4.5	60	5	39	5.5
2	800	50	5	42.5	5.5	40	4.5
3	900	45	5	26	7	35	7.5

Conclusions

Fabrication and characterization of group Ge-Ag materials of Ge-Ag were studied by I-V characteristic curves in this research. Moreover, I-V characterizations of Ge-Ag diode under the various light intensity on those diodes. The light dependence of I-V characteristics of silver (Ag) doped on germanium (Ge) substrates with different annealing temperatures, such as 700ºC, 800ºC, 900ºC were studied by various light intensities. The following conclusions may be resulted from these I-V characteristic curves:

Starting from initial voltage corresponding to the zero volt (0V), the current increases with rise in voltage. This is due to the increase in the number of conduction electrons in Ag metal as a result of ionization of the donors.

The current of each I-V characterization curves decreases with further increase in applied voltage. This is attributed to the decrease in the value of mobility with rise in applied voltage. There is also may be an increase in intrinsic conductivity but to a lesser extent in n-Ge materials.

Moreover, beyond the decreasing parts of I-V characteristic curves, oscillate until this saturated current conditions with increasing applied voltage. This oscillation nature of I-V characteristic curves of Ge-Ag diode in which the charge carrier (donors) electrons are abruptly moved by supplied voltages and/or the negative conductivity effects on· Ge-Ag diodes.

The reproducibility of these results of bouncing nature in curves because the diode exhibits switching, and oscillation due to intensity of light falling on it, or it is a light sensitive device. Thus, this Ge-Ag diode can be used as the light activated switch or optosensor.

Acknowledgements

The authors would like to acknowledge Dr Tin Maung Tun, Rector, University of Yangon, for his permitting and encouragement for this work. We would like to thank Professor Dr Yin Maung Mauung, Head of Department of Physics, University of Yangon, for his kind permission to carry out this work.

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