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ANALYSIS OF He-Ne LASER USING GERMANIUM TRANSISTOR

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Germanium and silicon are the two important semiconductors useful in the manufacture of large number of electronic devices. These devices are used in amplifiers, oscillators, energy converters, switches and many other applications. In the present work a Germanium transistor AC 128 has been chosen for the analysis of He-Ne Laser beam. The transistor was cut at its top and made-ready for illumination by a He-Ne Laser beam. The polarized beam falling through an analyzer on the Germanium material produces photo-voltage on the different transistor junctions. The developed photo-voltage across emitter-base, collector-base and emitter-collector terminals were measured. It is observed that the voltages developed across different junctions vary with Laser-intensity. Further the minima is observed at 120° analyzer angle of the Laser beam and a peak is observed at 230°. The second minimum is observed at 300° analyser angle corresponding to Laser intensities. Thus the germanium material serves as a good response material for the analysis of a He-Ne Laser beam. Finally the technique can be used to analyzer other Laser beams and finding response materials.

INTRODUCTION :

Experimental investigations on semiconducting materials using He-Ne laser are important as these explains laser damage resistance of these materials while most of the researches are focussed on silicon and III-V and II-VI group materials, the present investigations are centered on doped germanium as it has also proved to be a material useful in semiconducting devices. As the effect of He-Ne laser on the device material i.e. Germanium is to be studied; a transistor AC- 128 has been choosen to act as the material under investigations. This is important because it explains the optical properties of Germanium i.e., photo-conduction and photo-voltic effect at the illumination intensities of laser beam.

EXPERIMENTAL TECHNIQUE :

A transistor AC- 128 was taken for the present investigation. It was cut at its top so that the material is ready for illumination through a laser beam. A He-Ne laser beam was concentrated on the Germanium material of the transistor. The transistor electrodes were used in different combinations such as Base-Collector, Emitter-Collector and Base-Emitter modes. The laser beam was passed through a polariser and transmitted at zero set of the analyser and finally was allowed to fall on the germanium sample material of the transistor. The output from the irradiated germanium was measured using a digital meter. The analyser angle was varied in small regular steps of 100^0 each and corresponding photovoltage was measured. The experiment was repeated by using different electrode combinations. The distance of the laser beam was kept fixed in all these investigations from the material to be irradiated by laser beam.

RESULTS AND DISCUSSIONS

The graph showing the voltage developed across the two electrodes at different angles of laser radiation are shown in figures 1, 2 and 3. From first trace it is evident that the minimum response of the germanium material is observable at 120° and 300° analyser angles. Further the voltage developed due to the effect of the laser beam does not vary regularly but some kinks are observed. This indicates the irregular response of the germanium material through the complete cycle of illumination of laser beam. This can be explained as being due to the energy absorbed being greater than the band gap of the material. This discussion is limited to only base-emitter configurations of the transistor. The second trace shows the outputs at base-collector junctions. Here though the outputs are of higher values, but the minima's are observed again at 120° and 300° analyser angles. This is attributed to the fact that the bulk material on the collector side is more compared to that on the emitter side of the base. This gives rise to large number of carriers on the collector side compared to that on the emitter side. A similarity between the two curves is in fact few kinks are observed in the complete analyser cycle in the experiment. Fig. 3 shows the voltage developed on illumination of doped germanium with He-Ne laser beam at different analyser angles. This time the voltage developed on account of illumination measured across emitter and collector electrodes is of low values compared to the first two combinations. Further kinks are also observed in this case. One can say that diffusion of carriers takes place so also the recombination due to the depletion region on both sides of the base junctions. Consequently low values are expected in such studies.

CONCLUSION :

Using He-Ne laser, a strictly monochromatic wave-length illumination the optical response of doped germanium can be easily studied. Further the technique provide a deep view in the charge transport mechanism, recombination and diffusion using a simple device.

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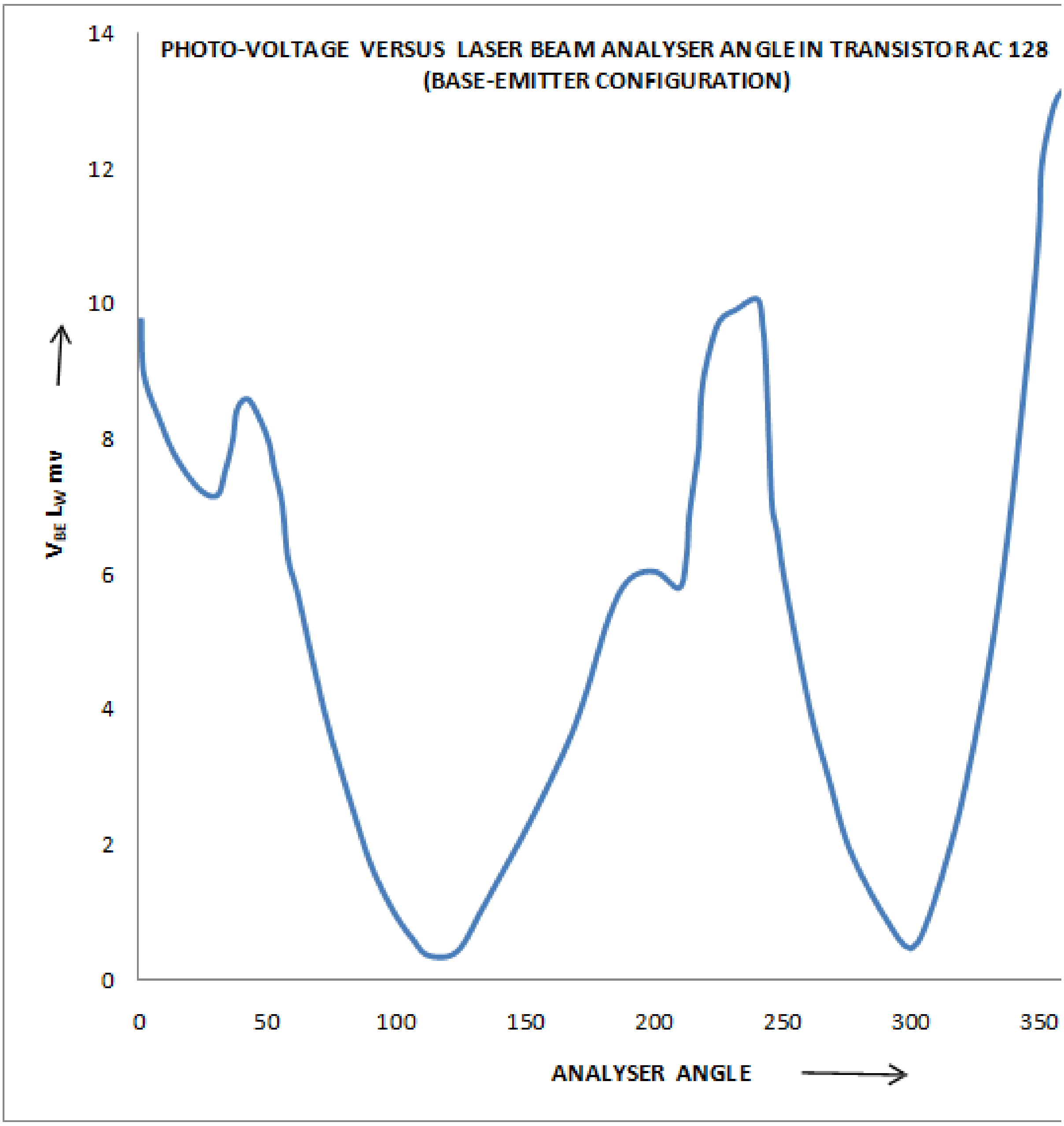

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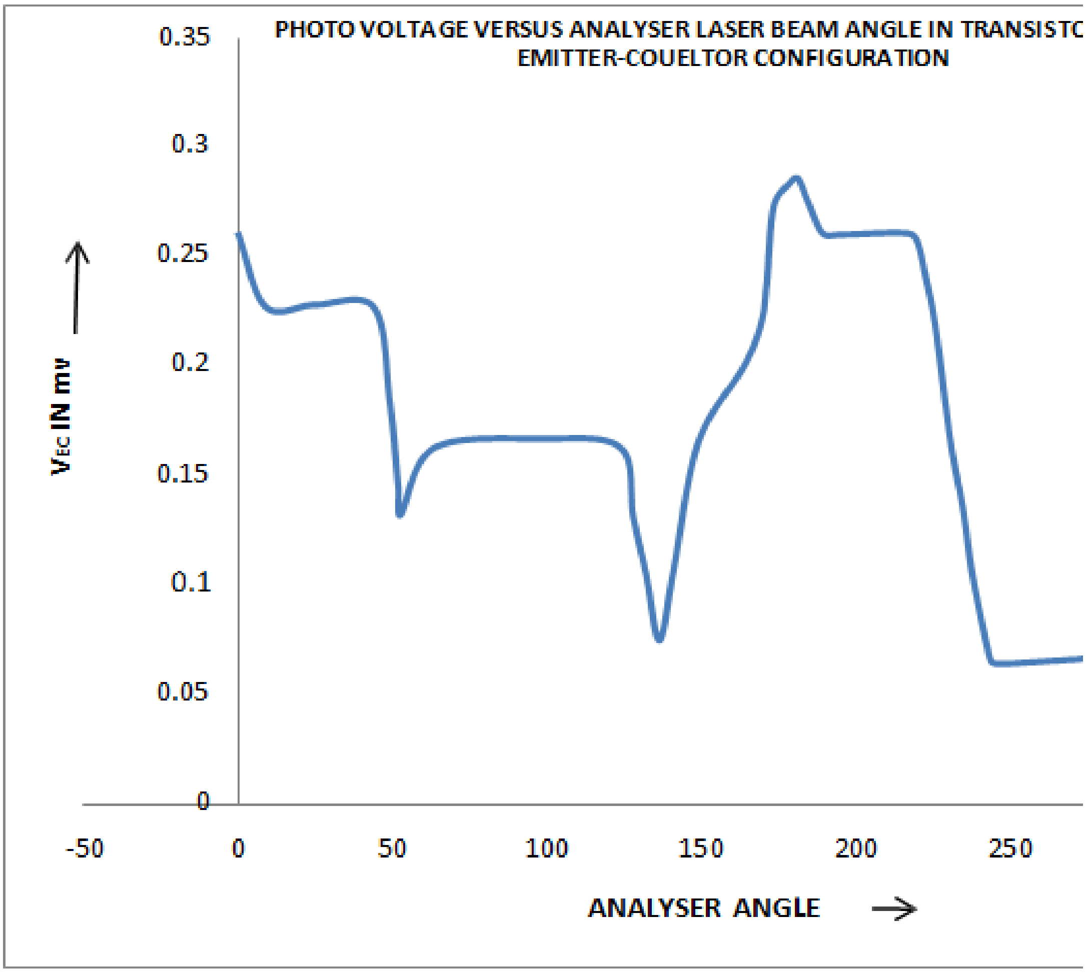

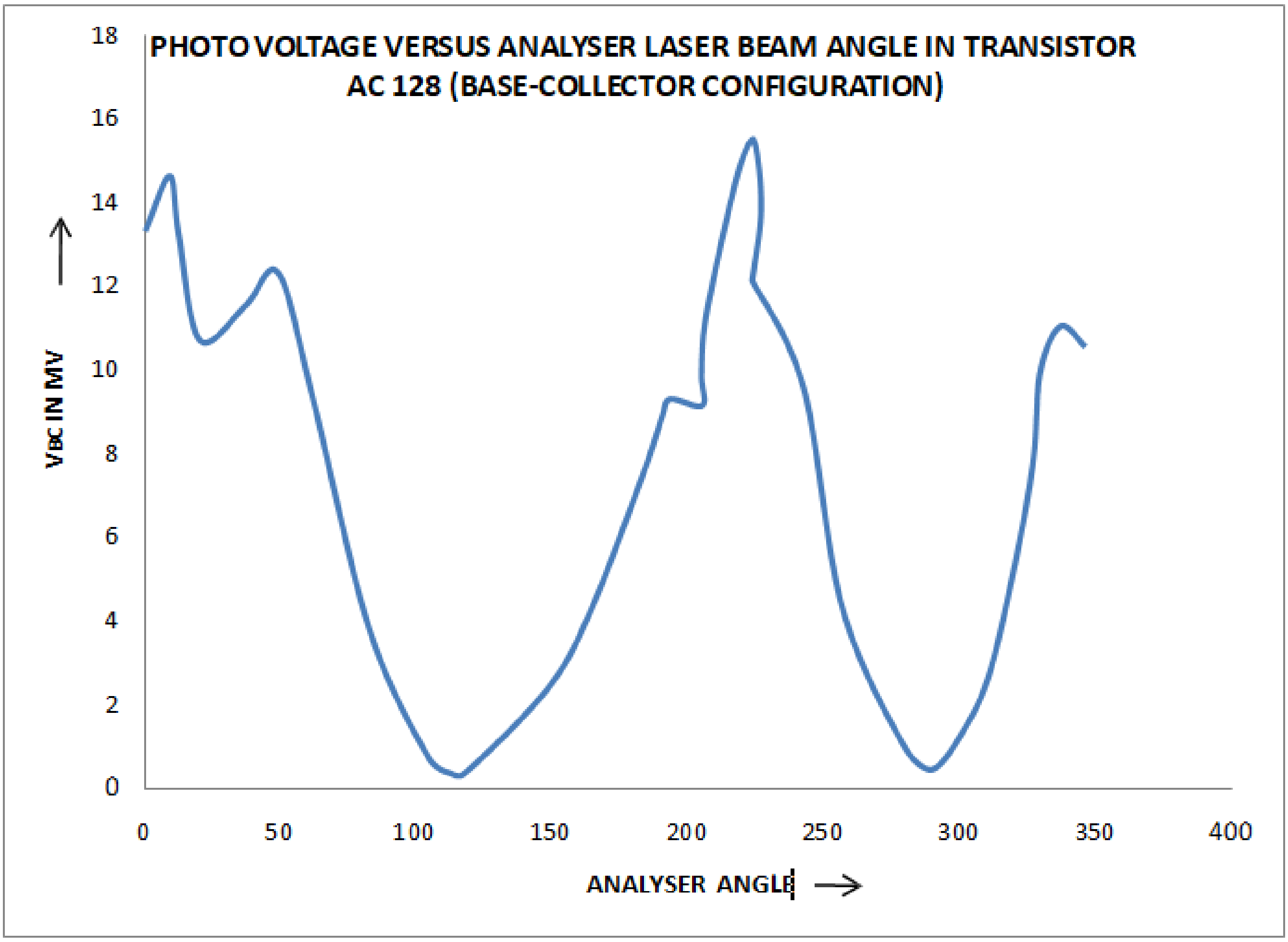
PHOTO VOLTAGE VERSUS ANALYSER LASER BEAM ANGLE IN TRANSISTOR AC 128 (BASE-COLLECTOR CONFIGURATION)
VBC IN MV
18
16
14
12
10
8
6
4
2
0
0
50
100
150
200
250
300
350
400
ANALYSER ANGLE