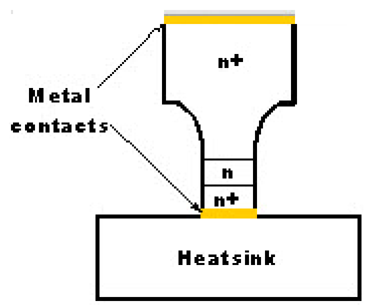
EXP NO: 15.1 STUDY EXPERIMENT - GUNN DIODE (MICROWAVE)

15.1.1 INTRODUCTION

GUNN Diodes (Transferred Electron Devices)

The Gunn diode (or transferred electron devices, TED) is a semiconductor component with negative resistance that converts the energy of a constant-voltage power source into the energy of high-frequency oscillations due to the formation of a strong field region (domain). Gunn diodes are negative resistance devices which are normally used as low power oscillator at microwave frequencies in transmitter and as local oscillator in receiver front ends.



It was invented by John Battiscombe Gunn in 1960s; after his experiments on GaAs (Gallium Arsenide), he observed a noise in his experiments' results and owed this to the generation of electrical oscillations at microwave frequencies by a steady electric field with a magnitude greater than the threshold value. It was named as 'Gunn Effect'. J B Gunn (1963) discovered microwave oscillation in Gallium arsenide (GaAs), Indium phosphide (InP) and cadmium telluride (CdTe).

These are semiconductors having a closely spaced energy valley in the conduction band as shown in Fig. 11.1 for GaAs.

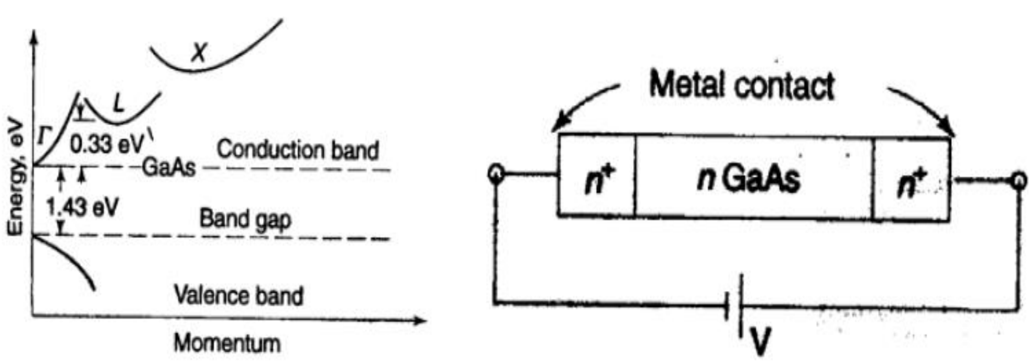


Fig. 1 Multi-valley conduction band energies of GaAs

Working:

When a dc voltage is applied across the material, an electric field is established across it. At low E-field in the material, most of the electrons will be in the lower energy central valley Γ. At higher E-field, most of the electrons will be transferred into the high-energy satellite L and X valleys where the effective electron mass is larger and hence electron mobility is lower than that in the low energy Γ valley. Since the conductivity is directly proportional to the mobility, the conductivity and hence the current decreases with an increase in E-field or voltage in an intermediate range, beyond a threshold value V_{th} as shown in Fig. 11.1. This is called the transferred electron effect and the device is also called 'Transfer Electron Device (TED) or Gunn diode'.

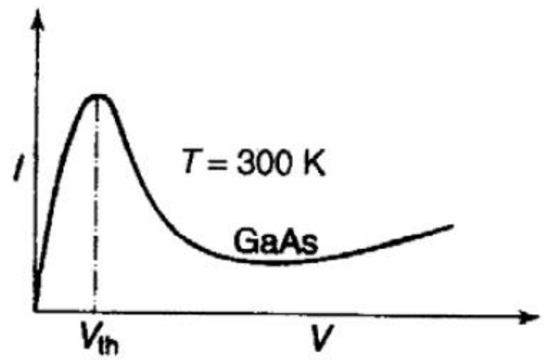


Fig.2 Current-voltage characteristics of GaAs

As shown in Fig 11.2, initially the current starts increasing in this diode, but after reaching a certain voltage level (at a specified voltage value called as threshold voltage value), the current decreases before increasing again. The region where the current falls is termed as a *negative resistance region*, and due to this it oscillates. In this negative resistance region, this diode acts as both oscillator and amplifier, as in this region, the diode is enabled to amplify signals.

SPECIFICATIONS:

Part Number: MG1041-MG1059

Features

- High Reliability
- Low-phase Noise
- 9.5-35.5Ghz Operation
- Pulsed and CW Designs to 20mW

15.1.2 PRE LAB QUESTIONS

1. What is GUNN diode?
2. Draw the equivalent Circuit for GUNN?
3. How many junctions are there in GUNN?
4. State Gunn effect?

15.1.3 POST LAB QUESTIONS

1. What are the different modes in GUNN diode oscillator?
2. Explain the transferred electron effect in GUNN?
3. What is negative derivative resistance in Gunn diode?
4. Name the semiconductor used in Gunn diode.
5. Explain the Two Valley Model Theory
6. What are applications of GUNN?

15.1.4 RESULT

The characteristics and the working of GUNN diode has been studied.

EXP.NO: 15.2 STUDY EXPERIMENT - OPTICAL WDM

15.2.1 INTRODUCTION

WAVELENGTH DIVISION MULTIPLEXING

Optical communication uses a special kind of multiplexing which is known as Wavelength division multiplexing or simply WDM. It is a type of multiplexing where light signals from multiple sources operating at slightly different wavelengths are multiplexed to transmit several information streams simultaneously over the same fiber.

WDM offers a further boost in fiber transmission capacity. Figure 11.3 shows the incorporation of WDM in an optical communication system.

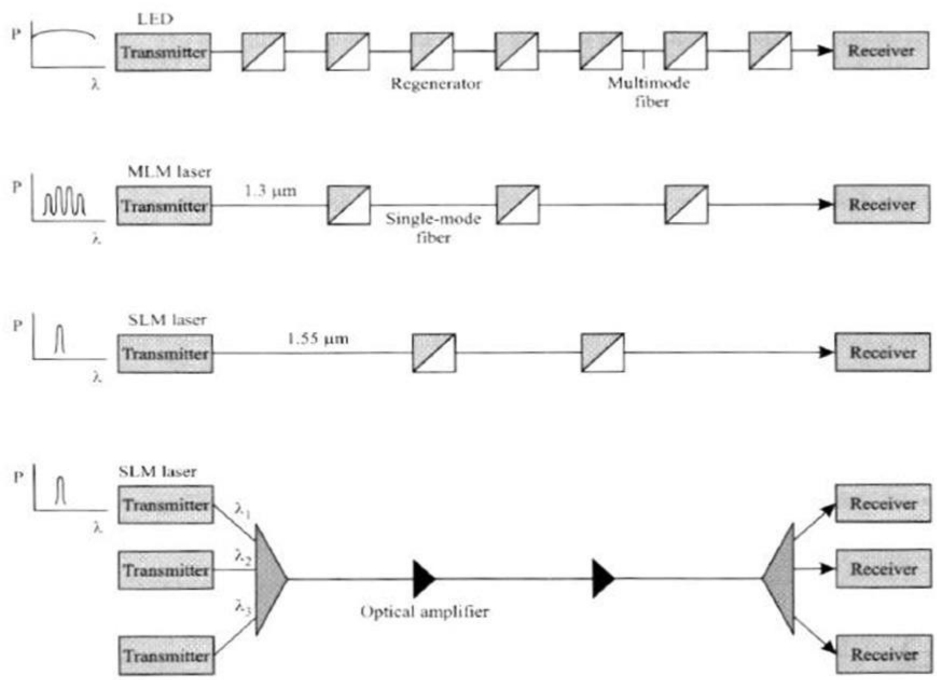


Figure 3 WDM Incorporated in Optical communication system

In fiber optic communication system, **wavelength-division multiplexing** (**WDM**) is a technology which multiplexes a number of optical carrier signals onto a single optical fiber by using different wavelength (i.e. colors) of laser light. This technique enables bidirectional communications over one strand of fiber, as well as multiplication of capacity.

A WDM system uses a multiplexer at the transmitter to join the signals together, and a multiplexer at the receiver to split them apart. With the right type of fiber, it is possible to have a device that does both simultaneously, and can function as an optical add-drop multiplexer. This is often done by use of optical-to-electrical-to-optical (O/E/O) translation at the very edge of the transport network, thus permitting interoperation with existing equipment with optical interfaces. Figure 11.4 shows the basic block diagram of WDM system is given below:

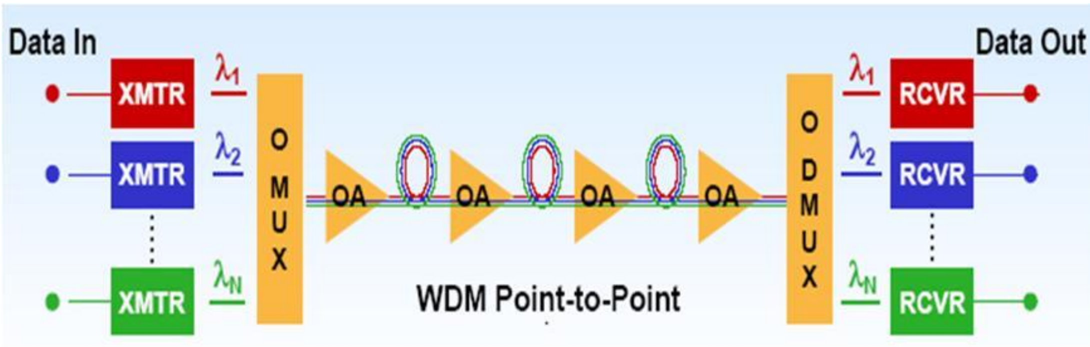


Fig 11.4 Basic block diagram of WDM system

WDM technology uses infrared light, which lies beyond the spectrum of visible light. It can use wavelengths between 1260nm and 1670nm. Most fibers are optimized for the two regions 1310nm and 1550nm, which allow for effective “windows” for optical networking.

WDM systems are divided into different wavelength patterns,

- **conventional/coarse** (CWDM) and
- **dense** (DWDM).

WDM, DWDM and CWDM are based on the same concept of using multiple wavelengths of light on a single fiber, but differ in the spacing of the wavelengths, number of channels, and the ability to amplify the multiplexed signals in the optical space. Conventional WDM systems provide up to 8 channels in the 3rd transmission window (C-band) of silica fibers around 1550 nm.

Dense wavelength division multiplexing (DWDM) uses the same transmission window but with denser channel spacing. Channel plans vary, but a typical system would use 40 channels at 100 GHz spacing or 80 channels with 50 GHz spacing. Some technologies are capable of 12.5 GHz spacing (sometimes called ultra-dense WDM). Such spacings are today only achieved by free space optics technology. DWDM can handle higher speed protocols, even 400Gbps per channel.

Coarse wavelength division multiplexing (CWDM) in contrast to conventional WDM and DWDM uses increased channel spacing to allow less sophisticated and thus cheaper transceiver designs. To provide 8 channels on a single fiber CWDM uses the entire frequency band between second and third transmission window (1310/1550 nm respectively) including both windows (minimum dispersion window and minimum attenuation window) but also the critical area where OH scattering may occur, recommending the use of OH-free silica fibers in case the wavelengths between second and third transmission window should also be used.

CWDM is a convenient and low-cost solution for distances up to 70km. But between 40km and its maximum distance of 70km CWDM tends to be limited to 8 channels due to a phenomena called the water peak of the fiber (more about this further down).

ITU STANDARDS

International Telecommunication Union (ITU) G.694.1 standard DWDM region is from 1528.77nm to 1563.86nm that resides mostly within the C band. DWDM can have 100GHz (0.8 nm) wavelength spacing for 40 channels, or 50GHz (0.4 nm) spacing for 80 channels. ITU-T G.694.2 defines 18 wavelengths for CWDM transport ranging from 1270 to 1610 nm, spaced at 20 nm apart. Fig 11.5 shows the wavelength chart for CWDM and DWDM.

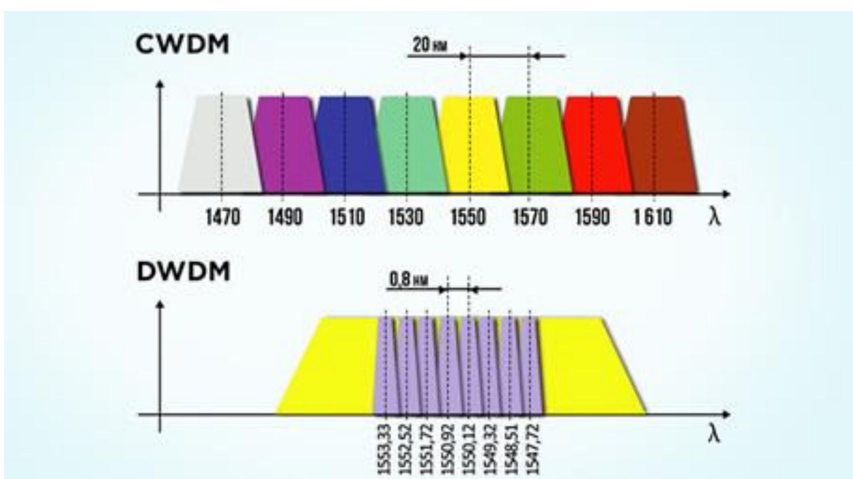


Fig 11.5 Wavelength chart for CWDM and DWDM

References:

1. vlab.amrita.edu, (2012). Wavelength Division Multiplexing. Retrieved 23 February 2021, from https://vlab.amrita.edu/index.php?sub=59&brch=269&sim=1373&cnt=1
2. http://www.iitg.ac.in/engfac/krs/public_html/lab/ee442/Exp5.pdf

15.2.2 PRELAB QUESTIONS

1) What band is used for shorter wavelength multimode fiber system?
2) WDM is an analog multiplexing technique to combine _______________ signals
3) What is the need of WDM in optical communication?
4) Mention the types of WDM
5) CWDM operating with 8 channels (i.e., 8 fiber optic cables) is called as the __________.

15.2.3 POST LAB QUESTIONS

1) Explain why Dense Wavelength Division Multiplexing (DWDM) networks can simultaneously carry different types of traffic at different speeds over an optical channel.
2) What is the property of Coarse Wavelength Division Multiplexing DWDM?
3) Difference between CWDM and DWDM
4) What is the maximum distance covered by CWDM?

15.2.4 RESULT

The characteristics and properties of optical WDM and its types has been studied.