V-I CHARACTERISTICS OF DIODE

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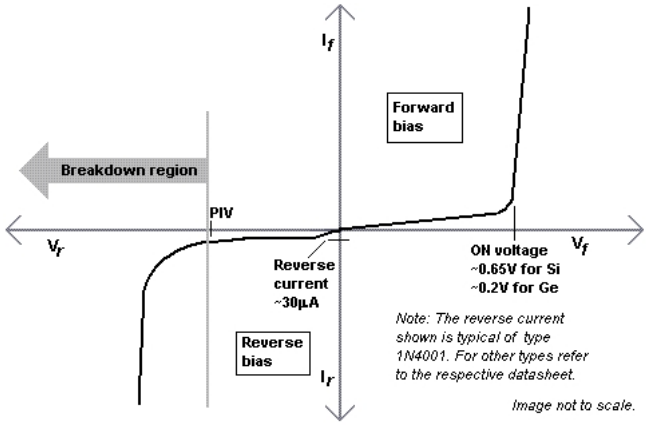
[1]

1. Aim

We try to see the Voltage-Current realtion in Diodes and compare the difference between various types of diodes including Zener Diode.

2. Theory

The diode is a device formed from a junction of n-type and p-type semiconductor material. The lead connected to the p-type material is called the anode and the lead connected to the n-type material is the cathode. In general, the cathode of a diode is marked by a solid line on the diode.The primary function of the diode is rectification. When it is forward biased (the higher potential is connected to the anode lead), it will pass current. When it is reversed biased (the higher potential is connected to the cathode lead), current flow is blocked.A general curve looks like this



In the forward-bias region the V-I relationship is described as follows:

$$I = I_s(e^{\frac{V}{nV_T}} - 1)$$

In the above equation, I is the forward current, V is the forward voltage, I_s is the saturation current, and V_T = kT/q is the thermal voltage ($k = 1.38x10^{-23}$ is Botzmann's constant, T is the absolute temperature in Kelvins, and $q = 1.6x10^{-19}$ is the electronic charge). The value of V_T at room temperature (20^oC) is $25.2mV$. The constant n in the diode equation above has a value between 1 and 2 depending on the material and physical structure of the diode.

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Here, we use two diodes in all, one is $IN4007$ and the other $BY127$ diode. An then, we also use a Zener Diode. A Zener Diode is constructed for operation in the reverse breakdown region. The relation between I-V is almost linear in this case $V_z = V_{z0} + I_z r_z$, where r_z is the dynamic resistance of the zener at the operating point. $V_z 0$ is the voltage at which the straight-line approximation of the I-V characteristic intersects the horizontal axis.

Actually, some basic uses of diodes are for regulating voltage in a circuit especially Zener diodes. The LED are also a very important use of diodes in that they are the most commonly used indicators. All diodes emit radiation when a electron meets a hole and falls into a lower energy state. The released photon is dependant on the band gap. So, for particular band gaps this released enery is chromatic. This does not happen in Silicon or Germanium diodes.

3. Procedure

First, complete a circuit as shown below with a 100Ω resistor and an variable DC input voltage source.

Now, let's take the diode BY127 and connect it if forward bias. The voltage that is supplied is a $5V$ which is connected through a variable voltage regulator. First locate the coltage at which the Ammeter starts deflecting for a current. Take this point. Now, keep increasing the voltage and take the current readings based calibration of the Ammeter. This will give us with about 7 points. If we require more than this sa as to get a more pronounced curve and how it is exponentiating we can use the DC voltage regulator at 30V.

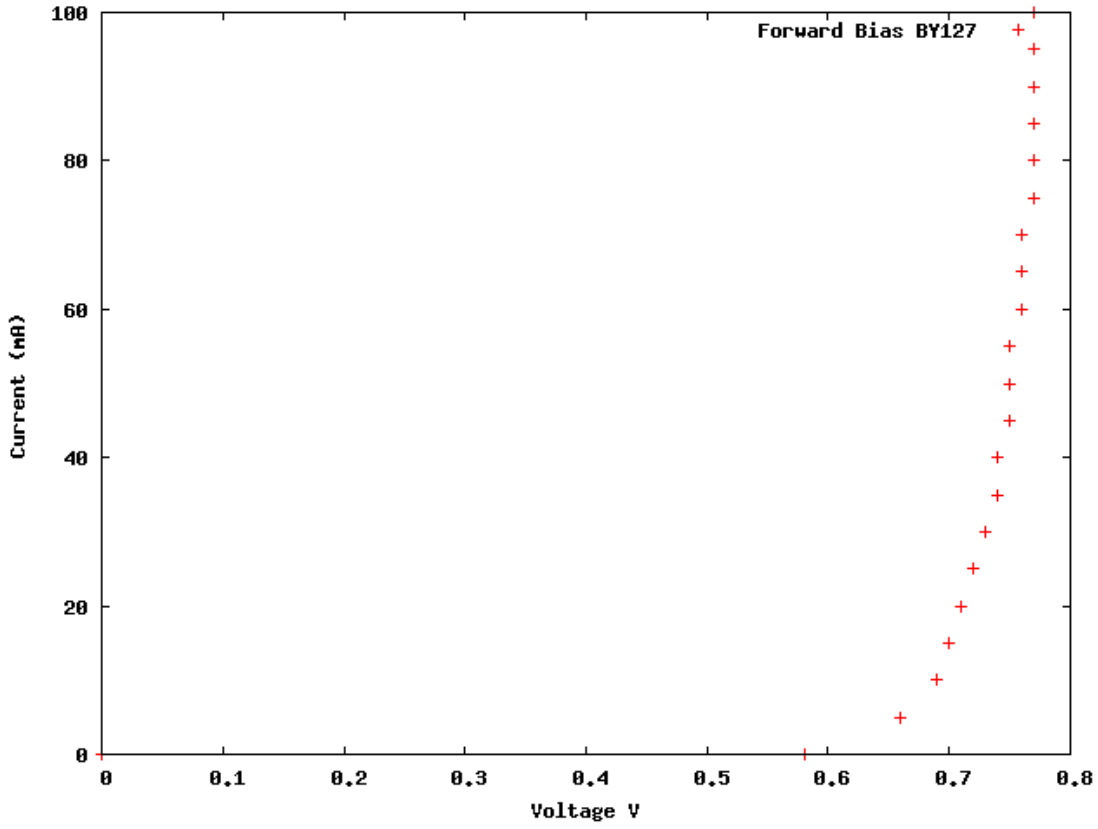
For reverse bias, connect the positive end of diode to the negative end of the circuit and vice-versa and now start taking the readings of Current and voltage. In this case the current cannot be observed on milliammeter. So, we should use a microammeter. Follow the same procedure as in the forward bias case.

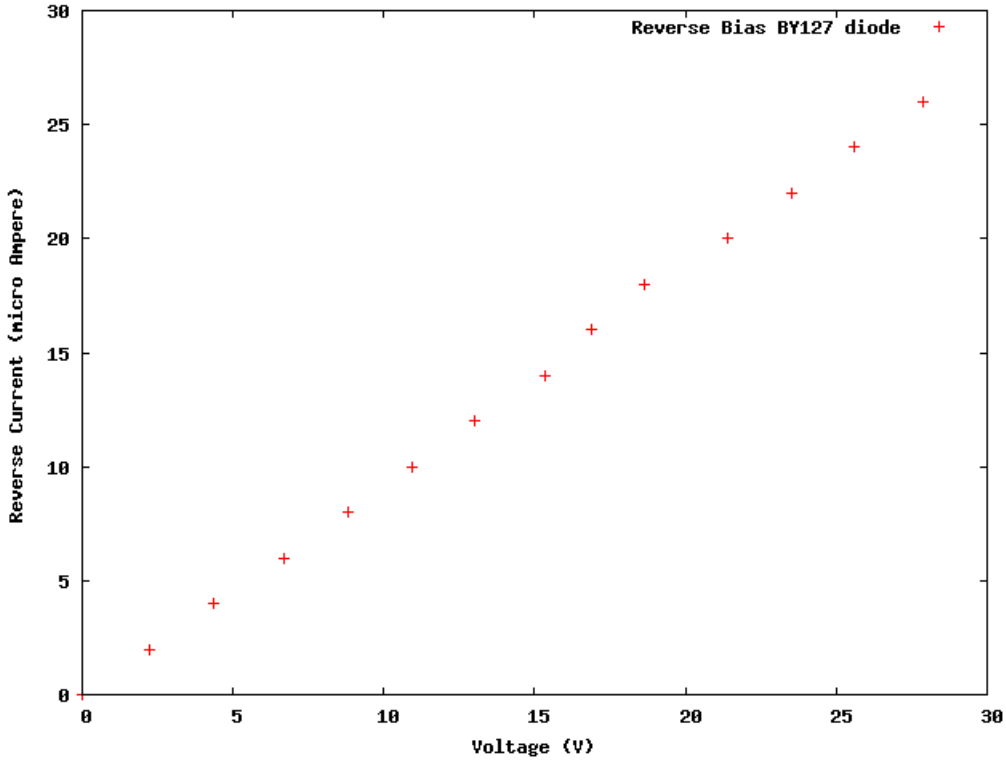
The same procedure is followed for IN4007 diode and a Zener Diode and the values of current and Voltage are tabulated to be later plotted as graphs of Voltage versus Current which are the V-i Charactersitic Curves of the particular diode and can be compared with other diodes in finding the point of breakdown and the slope of the linear parts of the reverse bias curves.

4. Observations and Results

- **BY127 diode:** The data table and the forward and revers bias curves are given below. The current is intially observed at $0.58V$ and from the graph we can see that the cut-off voltage is aroung 0.76 or 0.77.

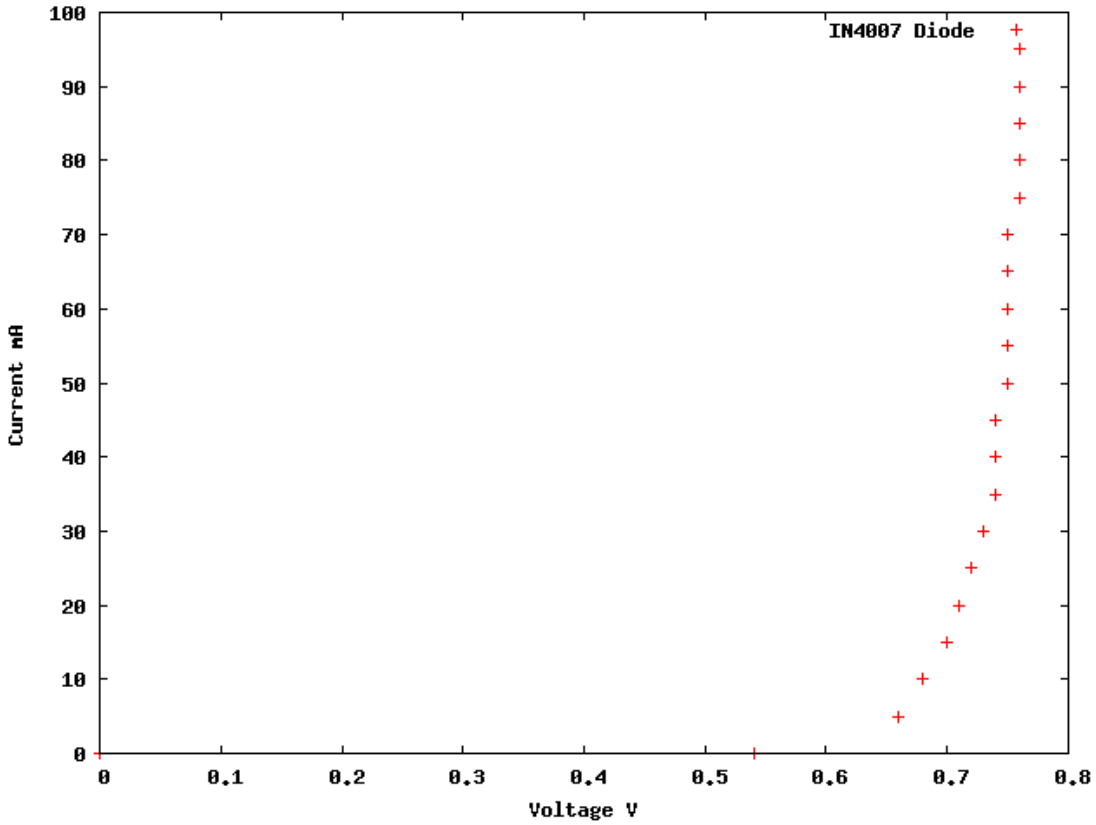
S.No	Forward Voltage (V)	Current (mA)	Reverse Voltage (V)	Current (μA)
1	0	0	0	0
2	0.58	0	2.24	2
3	0.66	5	4.34	4
4	0.69	10	6.70	6
5	0.70	15	8.84	8
6	0.71	20	10.94	10
7	0.72	25	13.00	12
8	0.73	30	15.35	14
9	0.74	35	16.88	16
10	0.74	40	18.66	18
11	0.75	45	21.4	20
12	0.75	50	23.5	22
13	0.75	55	25.6	24
14	0.76	60	27.9	26
15	0.76	65		
16	0.76	70		
17	0.77	75		
18	0.77	80		
19	0.77	85		
20	0.77	90		
21	0.77	95		
22	0.77	100		

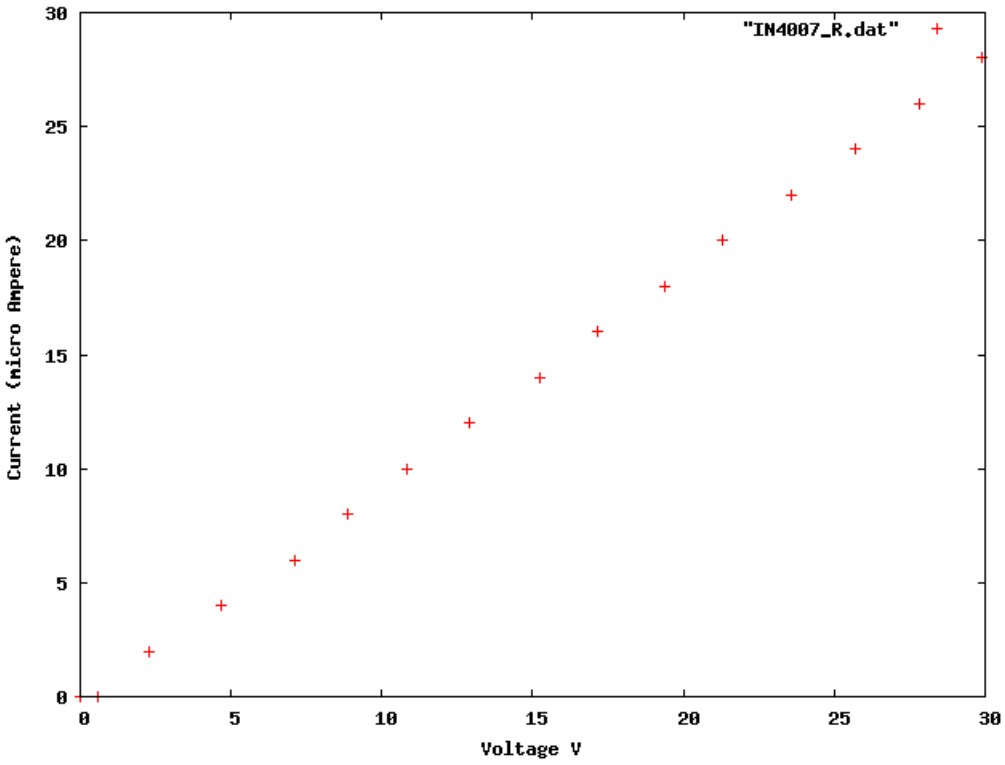




- **IN4007:**The Current is initially Observed at 0.54V. The cut off for this is also around $0.77V$. The data tables and graphs are given below.

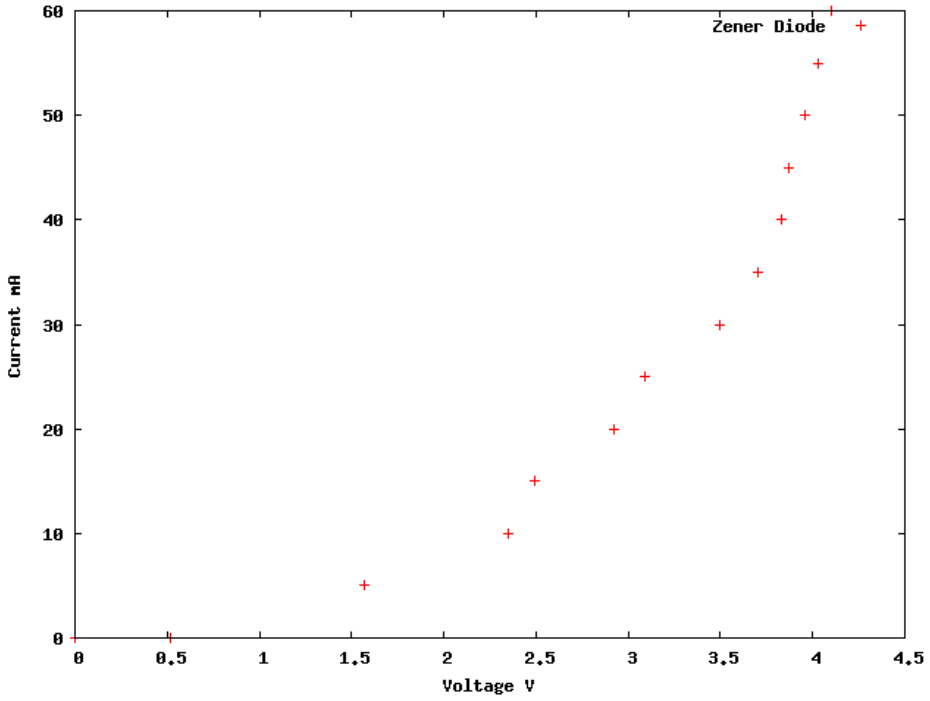
S.No	Forward Voltage(V)	Current(mA)	Reverse Voltage(V)	Current(μA)
1	0	0	0	0
2	0.54	0	0.59	0
3	0.66	5	2.3	2
4	0.68	10	4.69	4
5	0.70	15	7.13	6
6	0.71	20	8.89	8
7	0.72	25	10.84	10
8	0.73	30	12.92	12
9	0.74	35	15.23	14
10	0.74	40	17.14	16
11	0.74	45	19.38	18
12	0.75	50	21.3	20
13	0.75	55	23.6	22
14	0.75	60	25.7	24
15	0.75	65	27.8	26
16	0.75	70	29.9	28
17	0.76	75		
18	0.76	80		
19	0.76	85		
20	0.76	90		
21	0.76	95		

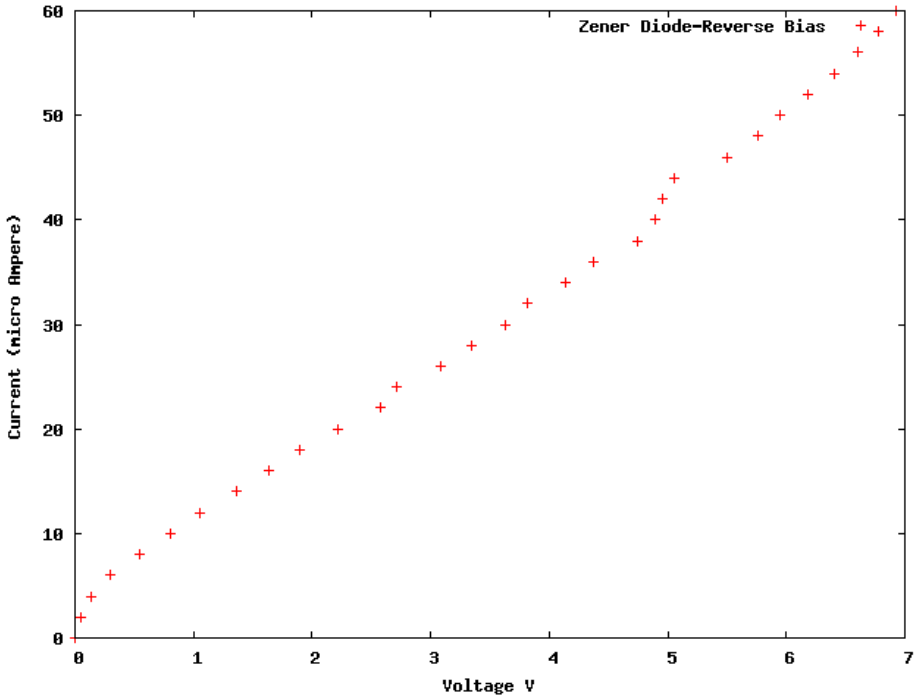

IN4007 Diode
Current mA
Voltage V
0
10
20
30
40
50
60
70
80
90
100
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8


"IN4007_R.dat"
Current (micro Ampere)
Voltage V
0
5
10
15
20
25
30

- **Zener Diode:** Here the point in reverse bias where the current starts showing up is $0.52V$. The reverse bias of this has a uch gentler slope than the normal diodes as expected. The data tables and graphs are given below.

S.No	Forward Voltage(V)	Current(mA)	Reverse Voltage(V)	Current(μA)
1	0	0	0	0
2	0.52	0	0.05	2
3	1.57	5	0.14	4
4	2.35	10	0.30	6
5	2.49	15	0.54	8
6	2.92	20	0.81	10
7	3.09	25	1.05	12
8	3.50	30	1.36	14
9	3.70	35	1.63	16
10	3.83	40	1.90	18
11	3.87	45	2.22	20
12	3.96	50	2.58	22
13	4.03	55	2.71	24
14	4.10	60	3.09	26
15			3.34	28
16			3.63	30
17			3.81	32
18			4.14	34
19			4.37	36
20			4.74	38
21			4.90	40
22			4.95	42
23			5.06	44
24			5.50	46
25			5.76	48
26			5.95	50
27			6.18	52
28			6.41	54
29			6.60	56
30			6.78	58
31			6.93	60





- **A general Comment on my Reverse bias data:** We can see that the reverse bias is linear which is because the range of the voltage across the diode in which the data was taken falls just in the range of the linear part of the reverse bias curve. When the experiment was later tried the MicroAmmeter did not work