EE 236 : Lab 1 Post-lab report

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1 Experiment 1 - Diode forward bias characteristics

1.1 Aim:

The aim of this experiment is to study the forward bias I-V characteristics of PN junction diodes, estimate the band gap of the semiconductor material used in the diodes, and calculate the ideality factor, reverse saturation current, and doping densities of various PN junction diodes

1.2 Design:

This experiment was done in 2 parts, first in simulation and then practical in lab. The design of the circuit was simply a voltage source connected with a potentiometer, which was providing variable voltage to a diode and a resistance in series, as can be seen in the figure below. The potentiometer was tweaked to change the voltage across diode and current across the resistor in series was measured, which is equal to current through diode.

1.3 Simulation result:

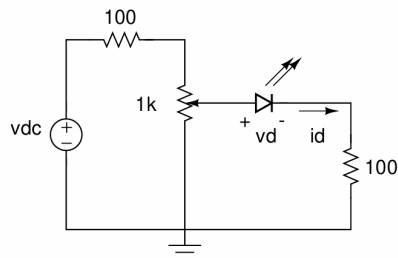Following are the code snippets and graphs for the simulation of the experiment on ngspice:
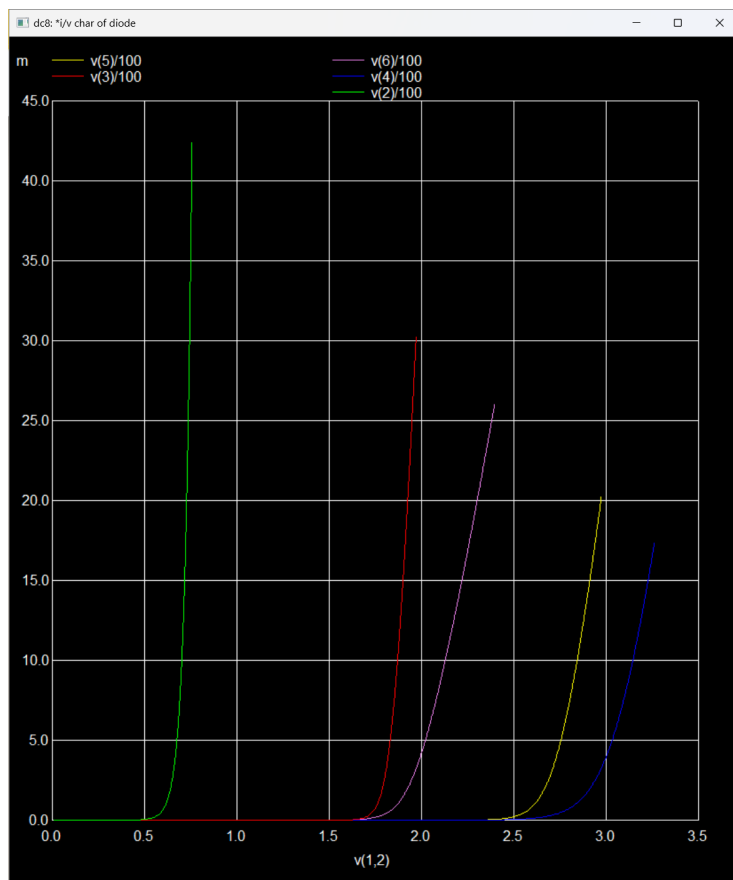

Figure 1: Caption

Figure 2: Id v/s Vd

```
1  *I/v char of diode
2  .include "D:\5th_semester\EE236\Lab1\Prelab\PN_1N4007.txt"
3  .include "D:\5th_semester\EE236\Lab1\Prelab\red_5mm.txt"
4  .include "D:\5th_semester\EE236\Lab1\Prelab\green_5mm.txt"
5  .include "D:\5th_semester\EE236\Lab1\Prelab\blue_5mm.txt"
6  .include "D:\5th_semester\EE236\Lab1\Prelab\white_5mm.txt"
7
8  vin 1 0
9
10 d1 1 2 1N4007
11 r1 2 0 100
12
13 d2 1 3 RED
14 r2 3 0 100
15
16 d3 1 4 WHITE
17 r3 4 0 100
18
19 d4 1 5 BLUE
20 r4 5 0 100
21
22 d5 1 6 GREEN
23 r5 6 0 100
24
25
26 .dc vin 0.01 5 0.01
27
28 .control
29 run
30 plot v(2)/100 vs v(1,2) v(3)/100 vs v(1,3) v(4)/100 vs v(1,4) v(5)
      /100 vs v(1,5) v(6)/100 vs v(1,6)
31 plot ln(v(2)/100) vs v(1,2) ln(v(3)/100) vs v(1,3) ln(v(4)/100) vs
      v(1,4) ln(v(5)/100) vs v(1,5) ln(v(6)/100) vs v(1,6)
32 .endc
```

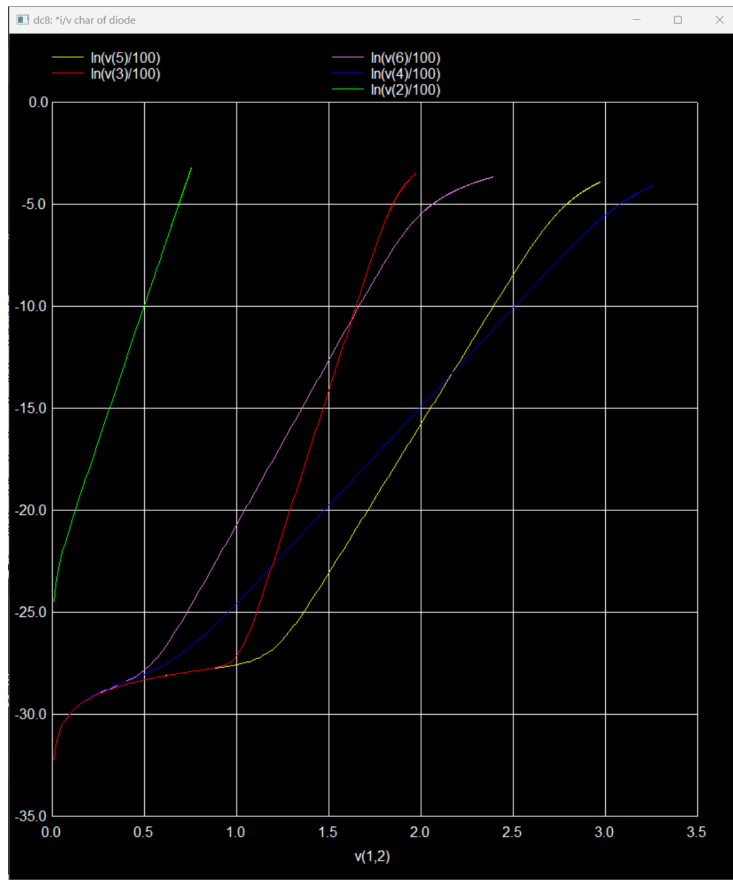Listing 1: Forward bias analysis of diodes

Figure 3: log of Id vs Vd

1.4 Experiment Results:

We took readings at multiple voltages and measured the current through diodes. Following are the readings and graph of the data.

| diode			green			red			white			blue		
Vd	Id	diode	Vd	Id	green	Vd	id	red	Vd	id	white	Vd	Id	blue
0.15	0		0.25	0		0.25	0		0.25	0		0.25	0	
0.25	0		0.45	0		0.45	0		0.5	0		0.5	0	
0.36	0		1	0		0.75	0.002	-6.21461	1	0		1	0	
0.44	0.037	-3.29684	1.5	0.002	-6.21461	1	0.002	-6.21461	1.5	0.002	-6.21461	1.5	0.002	-6.21461
0.49	0.11	-2.20727	1.6	0.002	-6.21461	1.2	0.002	-6.21461	1.8	0.002	-6.21461	1.8	0.002	-6.21461
0.51	0.173	-1.75446	1.79	0.002	-6.21461	1.38	0.002	-6.21461	2.23	0.002	-6.21461	2.23	0.002	-6.21461
0.53	0.238	-1.43548	1.88	0.002	-6.21461	1.53	0.003	-5.80914	2.34	0.002	-6.21461	2.32	0.002	-6.21461
0.55	0.328	-1.11474	2.01	0.004	-5.52146	1.58	0.005	-5.29832	2.41	0.002	-6.21461	2.43	0.006	-5.116
0.58	0.62	-0.47804	2.1	0.029	-3.54046	1.63	0.02	-3.91202	2.44	0.003	-5.80914	2.5	0.028	-3.57555
0.6	0.962	-0.03874	2.2	0.159	-1.83885	1.67	0.046	-3.07911	2.52	0.032	-3.44202	2.53	0.058	-2.84731
0.63	1.27	0.23902	2.3	0.588	-0.53103	1.71	0.128	-2.05573	2.53	0.078	-2.55105	2.57	0.116	-2.15417
0.65	2.42	0.88377	2.4	1.396	0.33361	1.75	0.375	-0.98083	2.56	0.164	-1.80789	2.6	0.194	-1.6399
0.69	5.43	1.69194	2.53	2.94	1.07841	1.8	1.017	0.01686	2.6	0.392	-0.93649	2.63	0.366	-1.00512
0.75	12.75	2.54553	2.75	6.74	1.90806	1.87	3.26	1.18173	2.63	0.845	-0.16842	2.7	0.767	-0.26527
			2.9	10.35	2.33699	1.95	9.34	2.23431	2.67	1.723	0.54407	2.73	1.088	0.08434
						2.01	14.68	2.68649	2.71	2.58	0.94779	2.77	1.854	0.61735
									2.8	6.32	1.84372	2.82	2.75	1.0116
									2.88	9.82	2.28442	2.95	5.22	1.6525
												3	8.63	2.15524

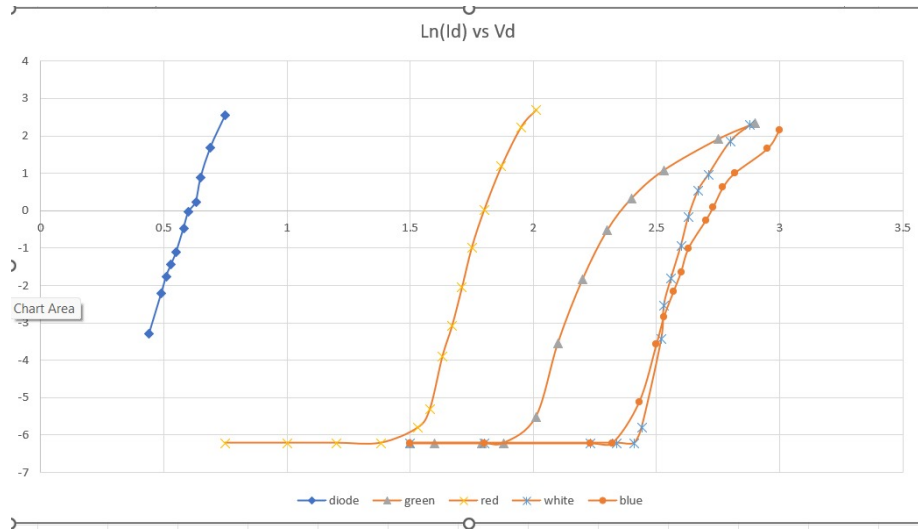Figure 4: Readings
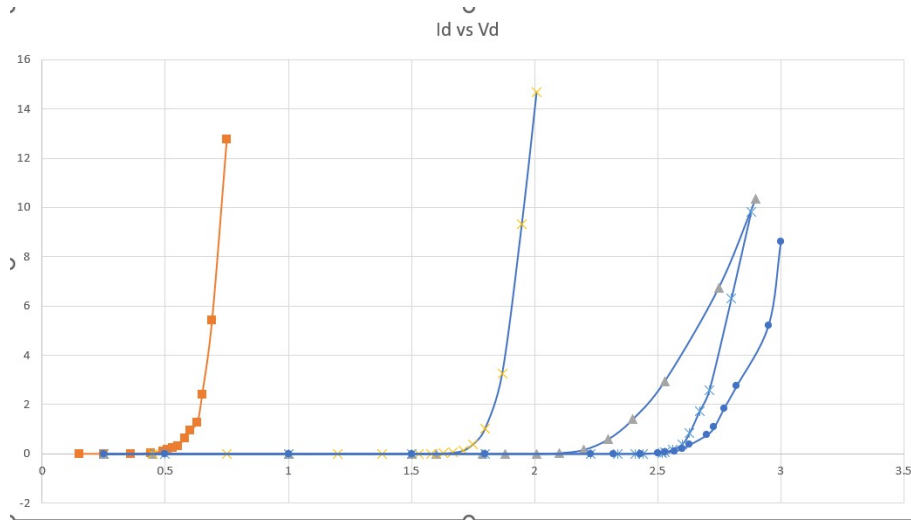
Figure 5: experimental data

Figure 6: Experimental data

1.4.1 Calculations:

The calculations were done from the collected data and following are the results:

Slope	intercept		ideality	Eg	cut-in voltage	Is
34.01481	-17.6397		1.1307292	1.1	0.6	1.36941E-09
11.50879	-24.831		3.3419268	2.367619	2.4	1.00997E-12
42.126	-72.6688		0.913012	1.979299	1.8	1.17177E-33
22.55429	-57.2123		1.7052872	2.762222	2.63	1.73227E-26
15.11722	-39.0384		2.5442201	2.731868	2.73	1.19305E-18

Figure 7: Calculation results

1.5 Conclusion and Inference:

The cut-in voltage increases with increase in band gap energy. This is because larger bandgap requires more energy to the electron to overcome, and hence more forward bias voltage.

1.5.1 Experiment Conclusion Status:

The experiment was completed and results were shown to the alloted TA.