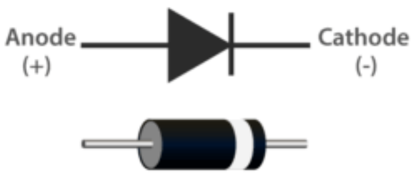
Diode Characteristics Experiment

I. INTRODUCTION

1.1. Diode

The most important element in a rectifier circuit is a **diode,** a circuit element that conducts current in one direction but not the other. Most diodes used in modern electronics are semiconductor devices. The circuit symbol for a diode is



where the arrow indicates the direction of the current through the diode. A diode has low resistance to current in one direction (the direction of the arrow) and high resistance to current in the opposite direction.

1.2.Current–voltage characteristic

A semiconductor diode's behavior in a circuit is given by its current–voltage characteristic, or I–V graph (see graph below). The shape of the curve is determined by the transport of charge carriers through the so-called *depletion layer* or *depletion region* that exists at the p–n junction between differing semiconductors.

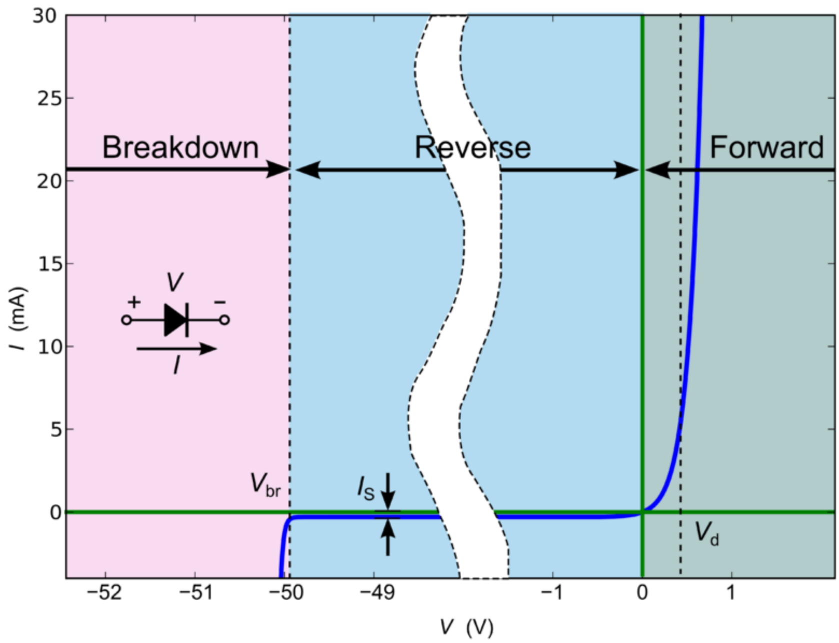


Figure 1. I–V (current vs. voltage) characteristics of a p–n junction diode

When a p–n junction is first created, conduction-band (mobile) electrons from the N-doped region diffuse into the P-doped region where there is a large population of holes (vacant places for electrons) with which the electrons "recombine". When a mobile electron recombines with a hole, both hole and electron vanish, leaving behind an immobile positively charged donor (dopant) on the N side and negatively charged acceptor (dopant) on the P side. The region around the p–n junction becomes depleted of charge carriers and thus behaves as an insulator.

However, the width of the depletion region (called the depletion width) cannot grow without limit. For each electron–hole pair recombination made, a positively charged dopant ion is left behind in the N-doped region, and a negatively charged dopant ion is created in the P-doped region. As recombination proceeds and more ions are created, an increasing electric field develops through the depletion zone that acts to slow and then finally stop recombination. At this point, there is a "built-in" potential across the depletion zone.

Reverse bias

If an external voltage is placed across the diode with the same polarity as the built-in potential, the depletion zone continues to act as an insulator, preventing any significant electric current flow (unless electron–hole pairs are actively being created in the junction by, for instance, light; see photodiode). This is called the *reverse bias* phenomenon.

Forward bias

However, if the polarity of the external voltage opposes the built-in potential, recombination can once again proceed, resulting in a substantial electric current through the p–n junction (i.e. substantial numbers of electrons and holes recombine at the junction). For silicon diodes, the built-in potential is approximately 0.7 V (0.3 V for germanium and 0.2 V for Schottky). Thus, if an external voltage greater than and opposite to the built-in voltage is applied, a current will flow and the diode is said to be "turned on" as it has been given an external *forward bias*. The diode is commonly said to have a forward "threshold" voltage, above which it conducts and below which conduction stops. However, this is only an approximation as the forward characteristic is smooth (see I-V graph above).

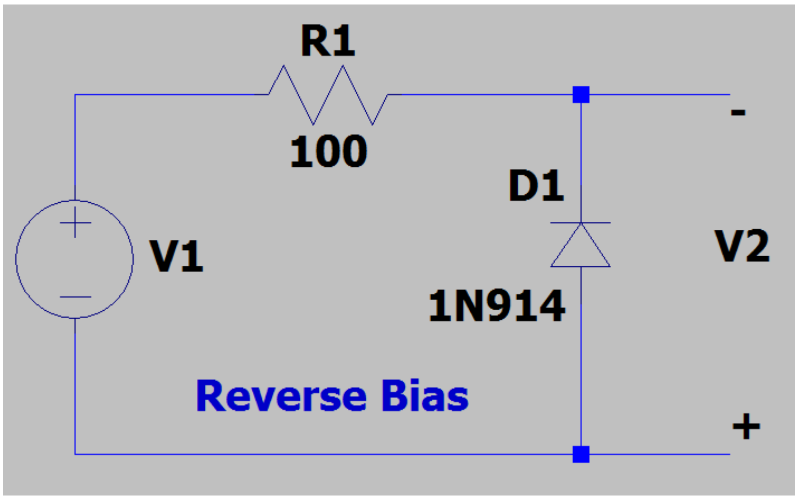
II.APPARATUS

Resistance, cables, multimeter, basic electrical set.

III. EXPERIMENTAL PROCEDURE

<u>Diode characteristics data (Reverse Bias)</u>

Reverse Bias		
Output Voltage V1 (V)	**Voltage drop across diode V2 (V)**	**Current (A)**
0	0	
1	1	
2	2	
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	
9	9	
10	10	



1) Set up the circuit provided on the up side.

2) If you have one multimeter, prepare it for 2 situations. You can use your multimeter for measuring current and voltage.

3) Please make the connection of power supply.

4) Do not forget that Ammeters are connected in series so that the current flows through them. The ideal ammeter has a resistance of zero. Real ammeters have some internal

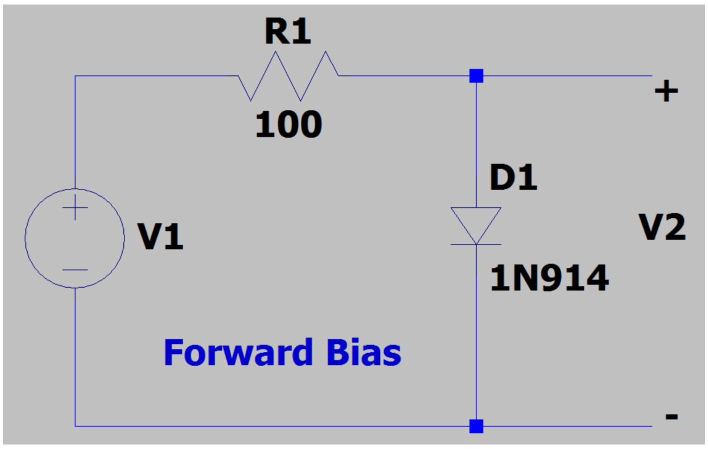
resistance. Voltmeters are connected in parallel to resistive elements in the circuit so that they measure the potential dfference across (on each side of) the element.

5) So please fill the Tabe 1 for this circuit.

6) Please plot I vs. V graph of diode for reverse bias?

Diode characteristics data (Forward Bias)

Forward Bias		
Output Voltage V1 (V)	**Voltage drop across diode V2 (V)**	**Current (A)**
0	0	
1	0,643	
2	0,707	
3	0,738	
4	0,76	
5	0,778	
6	0,792	
7	0,806	
8	0,818	
9	0,83	
10	0,84	



1) Set up the circuit provided on the up side.

2) If you have one multimeter, prepare it for 2 situations. You can use your multimeter for measuring current and voltage.

3) Please make the connection of power supply.

4) Do not forget that Ammeters are connected in series so that the current flows through them. The ideal ammeter has a resistance of zero. Real ammeters have some internal resistance. Voltmeters are connected in parallel to resistive elements in the circuit so that they measure the potential dfference across (on each side of) the element.

5) So please fill the Tabe 1 for this circuit.

6) Please plot I vs. V graph of diode for forward bias?

Ref.

1) Serway, R, Beichner,R. Physics for Scientists ans engineers with modern physics, Fifth edition. 2000.
2) Rentech.Experiments in electricity, student guide. 2013.

3) https://en.wikipedia.org/wiki/Diode

Table2		
Observation	**Ruler**	
	d_i(mm)	$a_i = d_i - d_{avg}$(mm)
1		
2		
3		
4		
5		
.		
.		
20		