SNS COLLEGE OF TECHNOLOGY

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB311- OPTICAL AND MICROWAVE ENGINEERING

III YEAR/ VI SEMESTER

UNIT II-MICROWAVE ACTIVE DEVICES

TOPIC 4-ELECTRON OSCILLATORS,AVALANCHE OSCILLATORS

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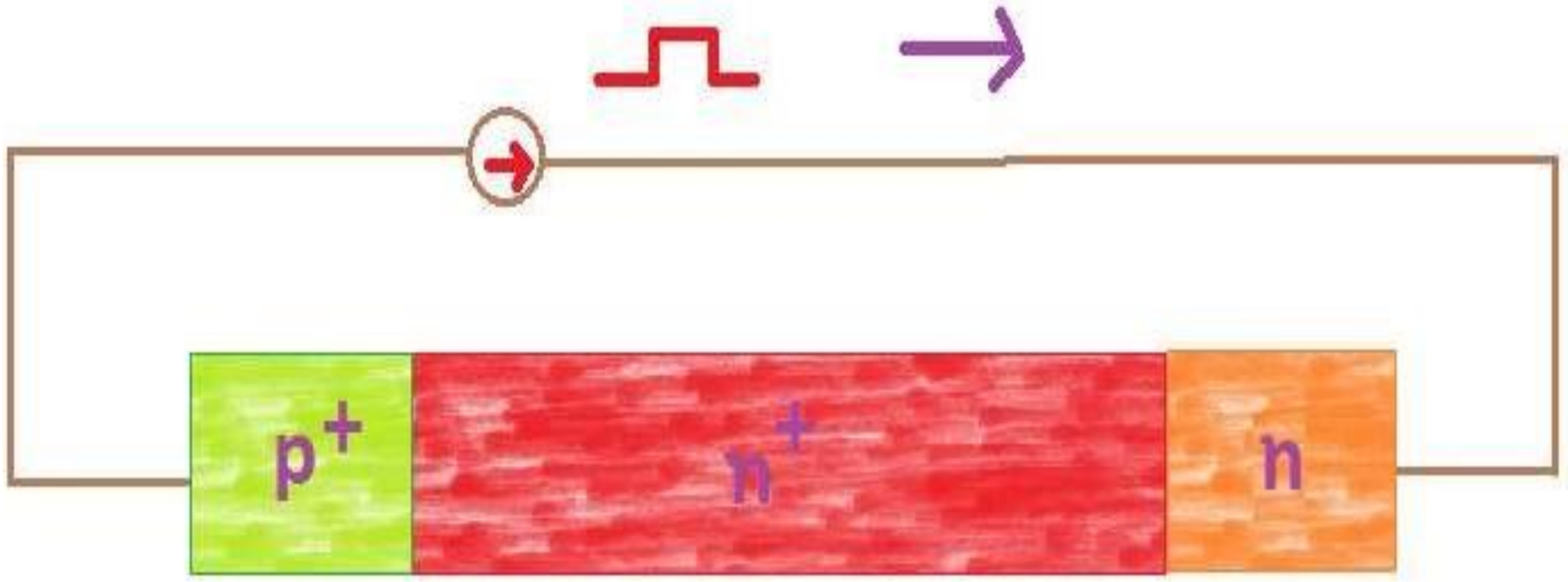
TRAPATT DIODE

- The TRAPATT (**Tra**pped **P**lasma **A**valanche **T**riggered **T**ransit) diode is another microwave energy which is used as both amplifier and oscillator.
- It was first reported by Prager in 1967.
- It operates efficiently below 10 GHz and need greater voltage swing for its operation.
- It is a p-n junction diode characterized by the formation of a trapped space charge plasma within the junction region.
- It is typically represented by a current pulse generator and the diode's depletion-layer capacitance.

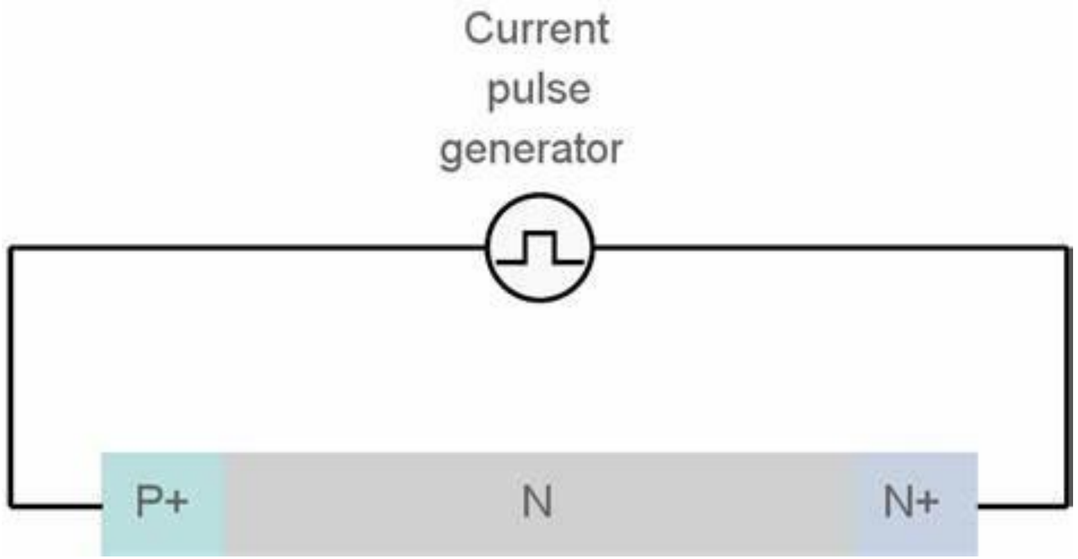
STRUCTURE

- Typically silicon with N type depletion region width=2.5 to 12.5 micro m
- p+ region = 2.5 to 7.5 micro m
- Diode’s diameter range=50 to 750 micro m

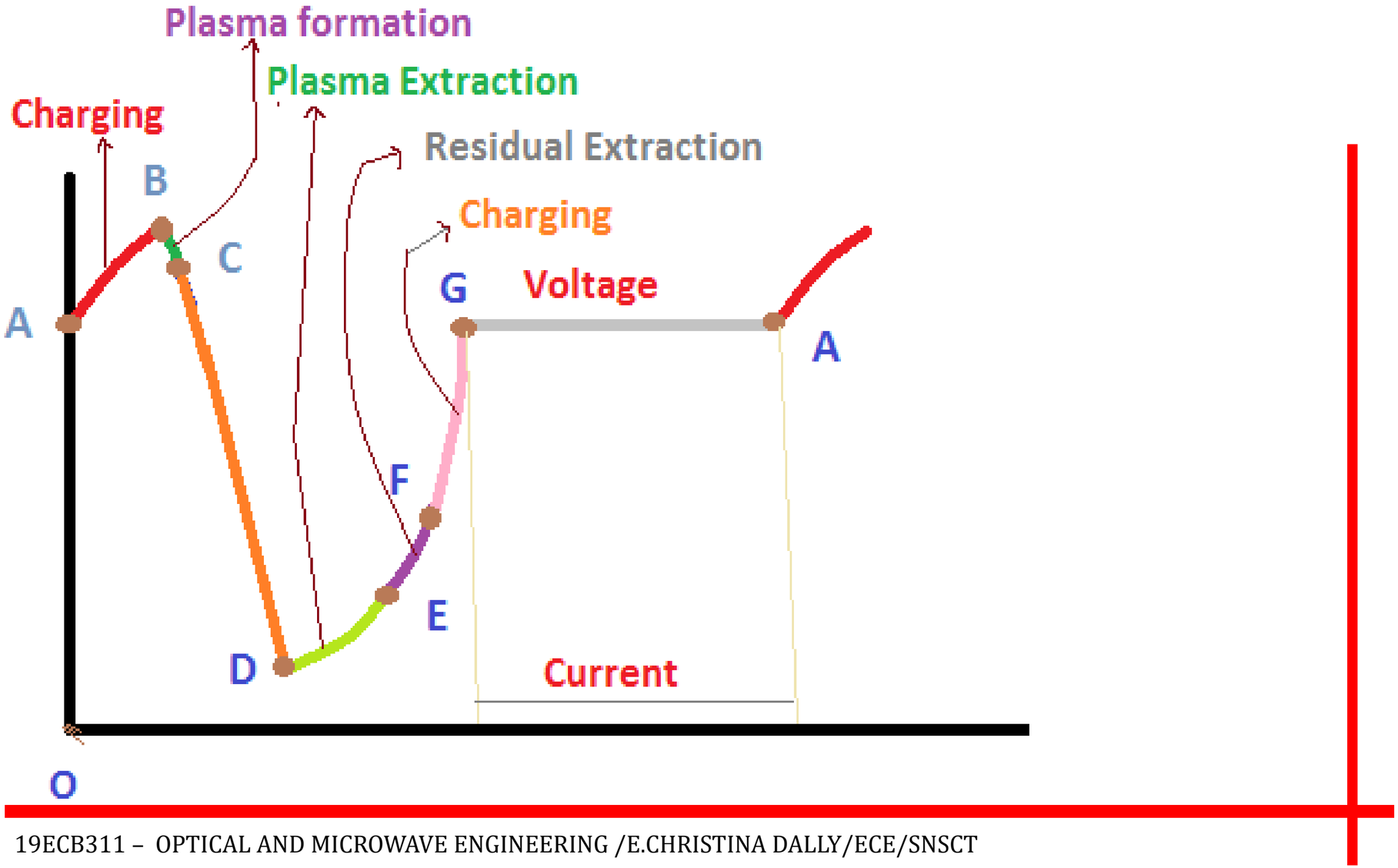


PRINCIPLE OF OPERATION

- A high field avalanche zone propagates through the diode.
- Fills the depletion layer with a dense plasma of electrons and holes that become trapped in the low field region behind the zone.



OPERATI ON


Plasma formation
Plasma Extraction
Charging
Residual Extraction
Charging
B
C
A
G
Voltage
A
F
E
D
Current
O

- At point A electric field is uniform throughout the sample but less than avalanche breakdown. Diode charge like a linear capacitor.

- When sufficient amount of carriers is generated, the electric field is depressed throughout the depletion region, causing the voltage to decrease. B to C a dense plasma of electron and hole is generated.

- At point C to D some of the electrons and holes drift out of the ends of the depletion layer the field is further depressed and traps the remaining plasma.

- A long time is required to remove the plasma as shown in graph from D to E.

- At point E the plasma is removed, but residual charge of electron in one end of the depletion region and residual charge of holes in other ends.

- At point F all the charges that was generated has been removed.
  The point F to G the diode charges like capacitor.

- At point G diode current goes to zero for half a period and the voltage remains constant at Vs until the current comes back on and the cycle repeats.

- The TRAPATT mode can operate at low frequencies since discharge time of plasma can be considerably greater than the nominal transit time of the diode at high field.

TYPICAL PARAMETERS

- Power = 1.2 kW at 1.2 GHz
- Maximum efficiency = 75% at 0.6 GHz
- Frequency range (operating) = 0.5 GHz to 50 GHz

TABLE 8-3-1 TRAPATT OSCILLATOR CAPABILITIES

Frequency (GHz)	Peak power (W)	Average power (W)	Operating voltage (V)	Efficiency (%)
0.5	600	3	150	40
1.0	200	1	110	30
1.0	400	2	110	35
2.0	100	1	80	25
2.0	200	2	80	30
4.0	100	1	80	20
8.0	50	1	60	15

Source: After W. E. Wilson [12]; reprinted by permission of Horizon House.

- RF power is delivered by the diode to an external load when the diode is placed in a proper circuit with the load.

ADVANTAGES

- 15 to 40% efficiency is obtained
- More suitable for pulsed operation
- It is much higher level of efficiency than the IMPATT diodes.
- Very low power dissipation.
- It can operate between 3 to 50GHz

DISADVANTAGES

- Noise figure is greater than 30dB, it is also very noisy.
- Not suitable for continuous operation because of its very high power densities.

APPLICATIONS

- Low power Doppler radars or local oscillators for radars.
- (http://www.spc.noaa.gov/faq/tornado/doppler.htm)
- Instrumental Landing system
- (http://microwave.landingsystem.com/)
- Radio altimeter (http://www.pacificavionics.com/)