Laboratory Report

Paschen Curve and Optical Emission Spectroscopy (OES) of discharge plasma

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Contents

Chapter 1

Introduction to the experiment

Objectives:

1. To study the generation of plasma, here using breakdown voltage method
2. To study the Paschen curve for various gases (N_2 and Ar) and find its properties
3. To try computing the value of the second Townsend coefficient γ
4. To analyse the Plasma spectrum of the two gases (N_2 and Ar) and try to get the electron temperature.

Theory:

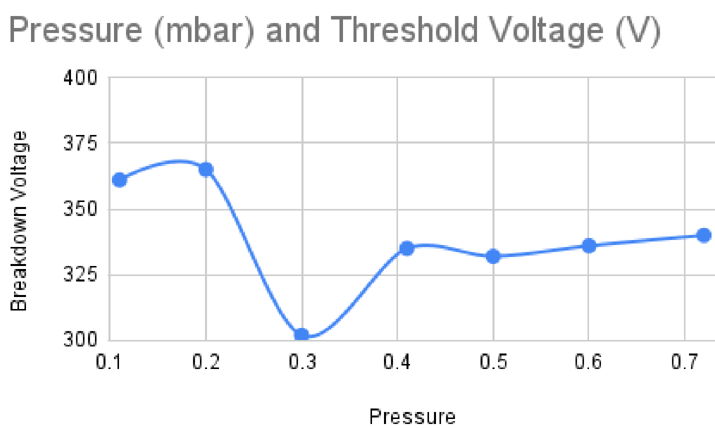
Chapter 2

Study of Paschen curves

2.1 Observations:

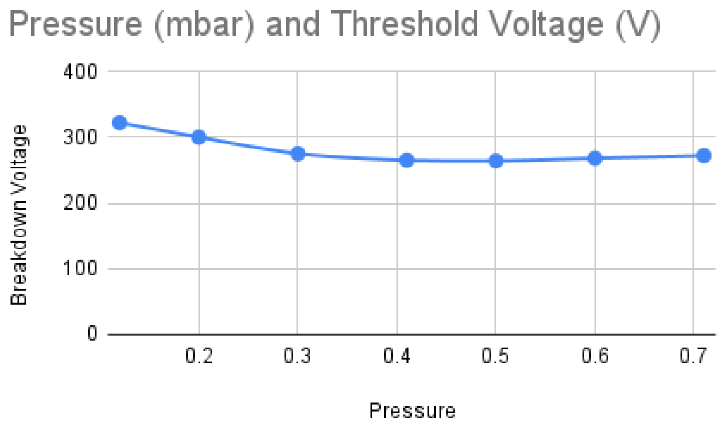
2.1.1 Argon where the Ring is Cathode

Base Pressure (mbar)	Pressure (mbar)	Threshold Voltage (V)	Current (mA)	Pressure	Voltage + 25	Current (mA)
0.05	0.11	361	1	0.1	385	3
0.038	0.2	365	2	0.2	390	3
0.034	0.3	302	1	0.3	327	2
0.032	0.41	335	4	0.4	360	5
0.029	0.5	332	5	0.5	357	6
0.029	0.6	336	6	0.6	360	7
0.027	0.72	340	8	0.72	360	9



2.1.2 Argon when the Ring is Anode

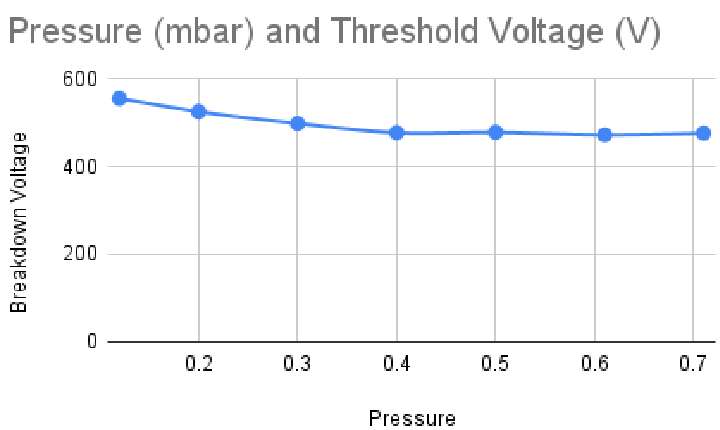
Base Pressure (mbar)	Pressure (mbar)	Threshold Voltage (V)	Current (mA)	Pressure
0.035	0.12	322	31	0.1
0.028	0.2	300	26	0.2
0.027	0.3	275	11	0.3
0.027	0.41	265	8	0.4
0.027	0.5	264	8	0.5
0.027	0.6	268	10	0.6
0.026	0.71	272	12	0.72



We are not increasing the Voltage by 25 V and analysing this time considering high current, which may damage the apparatus

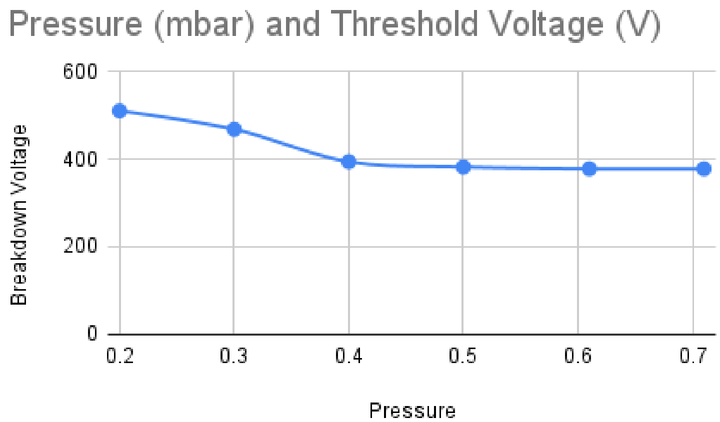
2.1.3 Nitrogen where the Ring is Cathode

Base Pressure (mbar)	Pressure (mbar)	Threshold Voltage (V)	Current (mA)	Pressure	Voltage + 25	Current (mA)
0.036	0.12	555	3	0.1	570	3
0.029	0.2	525	4	0.2	540	3
0.02	0.3	498	4	0.3	513	4
0.029	0.4	477	5	0.4	495	5
0.029	0.5	478	6	0.51	493	6
0.028	0.61	472	6	0.61	487	7
0.029	0.71	476	7	0.72	491	7



2.1.4 Nitrogen when the Ring is Anode

Base Pressure (mbar)	Pressure (mbar)	Threshold Voltage (V)	Current (mA)	Pressure
0.028	0.2	510	84	0.2
0.03	0.3	468	71	0.3
0.029	0.4	394	32	0.4
0.029	0.5	382	24	0.51
0.029	0.61	378	21	0.61
0.029	0.71	378	18	0.72



* *We are not increasing the Voltage by 25 V and analysing this time considering high current, which may damage the apparatus*
The discrepancies in the shape of the Paschen curve may arise due to the fact that the Paschen curve is derived considering parallel plate condition while we have taken a ring and pipe structure.

2.2 Analysis

Trying to find the Townsend coefficient

We have the Paschen curve formula

$$V = \frac{Bpd}{ln\left(\frac{Apd}{ln(1+\gamma^{-1})}\right)}$$

Minimizing, we get

$$V_{min} = 2.71828\frac{B}{A}ln(\gamma^{-1}+1)$$

We have the data for B and A as (In $(Pa.m)^{-1}$)

Gas	A	B
N_2	13	413
Ar	16	240

Now we make a Hypothesis to find out an approximate Townsend coefficient.
Approximation: The minimum V obtained in the experiment can be taken as the minimum V for the Paschen curve. So if we rewrite the expression for V_min as

$$\frac{1}{\gamma} = exp\left(\frac{V_{min}.A}{2.71828.B}\right) - 1$$

We get approximate Townsend coefficient as

Gas	γ when ring is anode	γ when ring is cathode
N_2	0.07	0.09
Ar	0.06	0.052

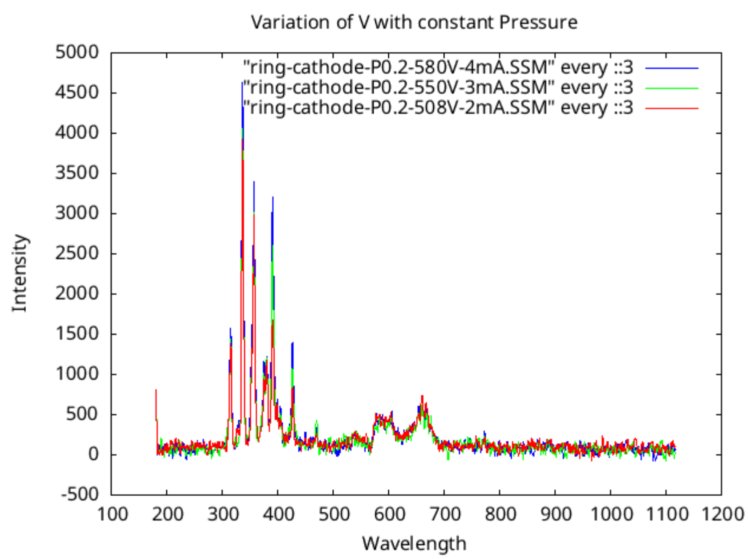
Chapter 3

Optical Emission Spectroscopy(OES)

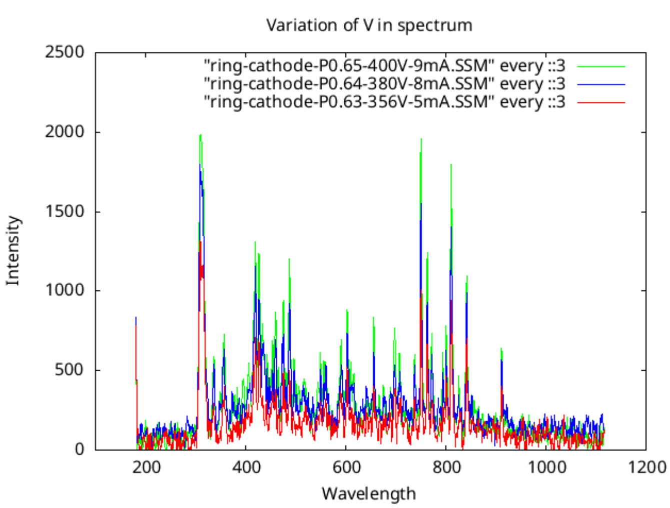
3.1 Observations:

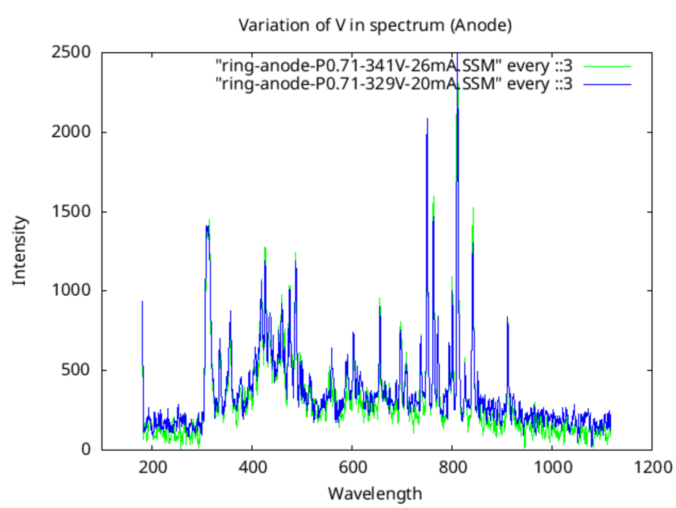
3.1.1 Variation of Voltage for the Same Pressure

Nitrogen



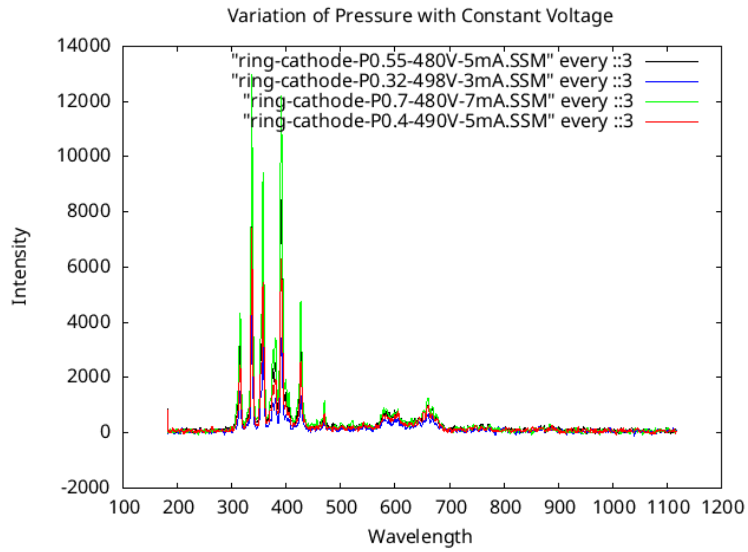
Argon



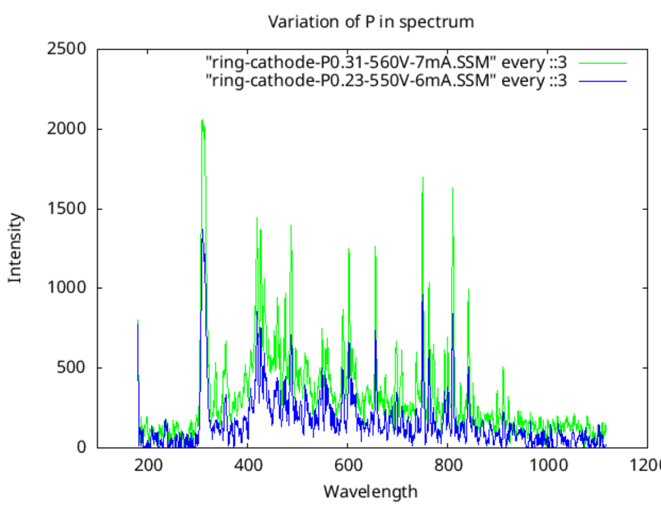


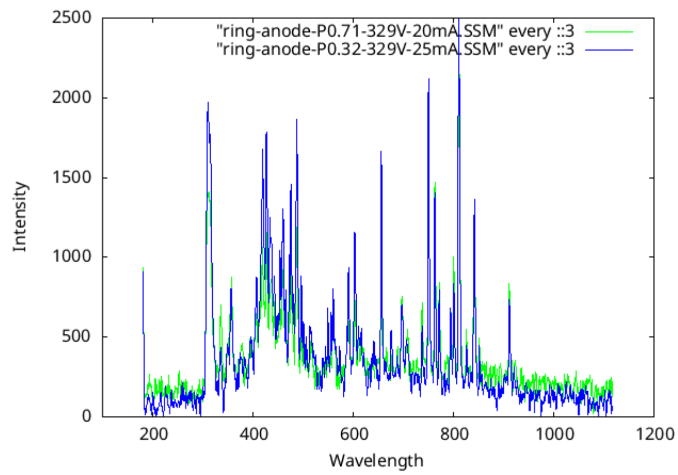
3.1.2 Variation of Pressure for the Same Voltage

Nitrogen

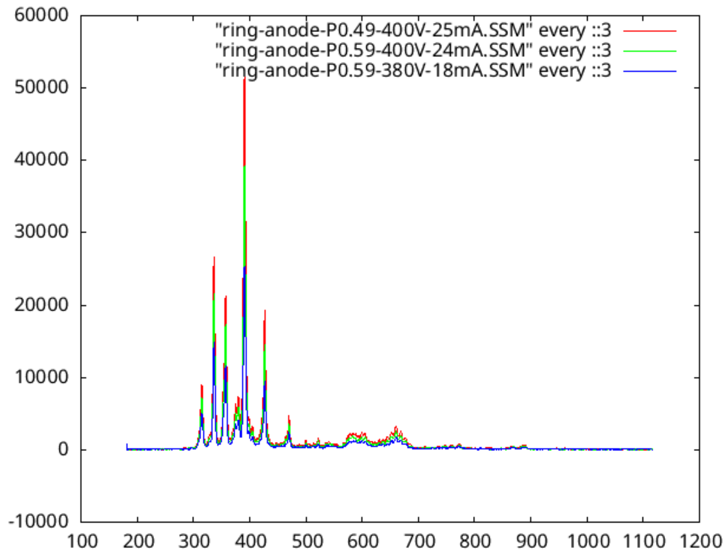


Argon





3.1.3 Nitrogen with ring as anode



3.2 Analysis of the Above Graphs

References: