VESPA
Vaso per Esperimenti Su Plasmi ed Altro

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1 Aims

Study the *Vespa* experimental apparatus, and in particular:

- Model the vacuum system behavior, finding the characteristic parameters;
- Obtain the current-voltage and the current-temperature characteristics curves of the filament;
- Draw the voltage-current characteristics curves of the gas discharge, enhancing their behavior as varying pressure;
- Find the Paschen curve, both in DC and RF condition;
- Measurement of plasma parameters through a Langmuir probe, both in stationary conditions and via ionic-sonic wave propagation.

2 Vacuum system

The vacuum inside the VESPA vessel (a cylindrical vessel, with a length of $\sim$ 80cm and a radius of $\sim$ 20cm) is obtained and keep thanks to a rotary pump and a turbomolecular pump. The vessel is not perfectly isolated and some small leaks affect the vacuum keeping. To study this phenomena, the vessel has been taken to a low pressure (...) and all the valves around has been closed. Measuring (thanks to a ionization pressure gauge) the pressure in the vessel as function of the time, effect as leaks and degasing can be observer. insert pressure

Highering pressure plot

Subsequently, the valves has been opened; the turbomolecular pump acts to extract all the gas from the vessel, and therefore a pressure lowering can be observed.

Lowering pressure plot

3 Voltage-Current characteristic of the filament

The filament inside the vessel is a tungsten filament with diameter $2r \sim 0.25$mm and length $L \sim 10$cm. Combining Ohm law and emissivity rules, a theoretical characteristic curve can be obtained:

$$V = \frac{A^{10/7} L}{\pi^{13/7} r^{23/7} (2\epsilon\alpha)^{3/7}} \cdot I^{13/7}$$

where ϵ is the effective emissivity, α the StefanBoltzmann constant and A a the resistivity proportional constant, such that the resistivity ρ can be expressed as function of the temperature T as

$$\rho(T) = AT^{6/5}$$

Pumping the vessel to a low density (...), the voltage-current characteristic curve of the filament has been measured, producing the following data: how much?

Plot V-I filamento

Fitting the data with a $V \propto I^{13/7}$, the following parameters are found:

$$V = mI^{13/7} + q \tag{1}$$
$$m = ... \tag{2}$$
$$q = ... \tag{3}$$

which lead to a value of

$$\epsilon = ...$$

Finally, the estimated filament temperature as a function of the driven current can be found:

$$T = \frac{A^{5/14}}{\pi^{5/7} r^{15/14} (2\epsilon\alpha)^{5/14}} \cdot I^{5/7}$$

Insert T-I plot