Electron Diffraction

Apparatus required

1. Electron diffraction tube with stand
2. High voltage power supply (up to 10 kV)
3. Connecting wires
4. **Plastic** measuring scale

Objective

To calculate the interplanar spacing in graphite from the diffraction pattern.

Basic Information

In this experiment electrons get *transmitted* through a *very thin* polycrystalline graphite sheet. The schematic sketch is shown in Fig. 1. Graphite has two independent lattice spacings (d_1 and d_2) and these are shown in Fig. 2. The two diffraction rings that will be seen at each voltage are due to these two planes.

Applying the diffraction formula for first order, we have,

$$\lambda = d \sin\theta \tag{1}$$

where λ is the de Broglie wavelength of the electron, d is the interplanar spacing and θ is the angle of diffraction. Electrons are accelerated through a potential difference of 'V' Volts and hence their de Broglie wavelength is,

$$\lambda = \frac{12.3}{\sqrt{V}}\,\text{Å} \tag{2}$$

From the geometry of Fig. 1 we have,

$$\sin\theta = \frac{R}{\sqrt{R^2+L^2}} \tag{3}$$

Upon simplifying and using the fixed value of L = 13.5 cm and R expressed in cm,

$$\sin\theta = \frac{1}{\left(1+\left(\frac{13.5}{R}\right)^2\right)^{0.5}} \tag{4}$$

Interplanar spacing can be calculated from equation (1) by substituting equations (2) and (4) into it.

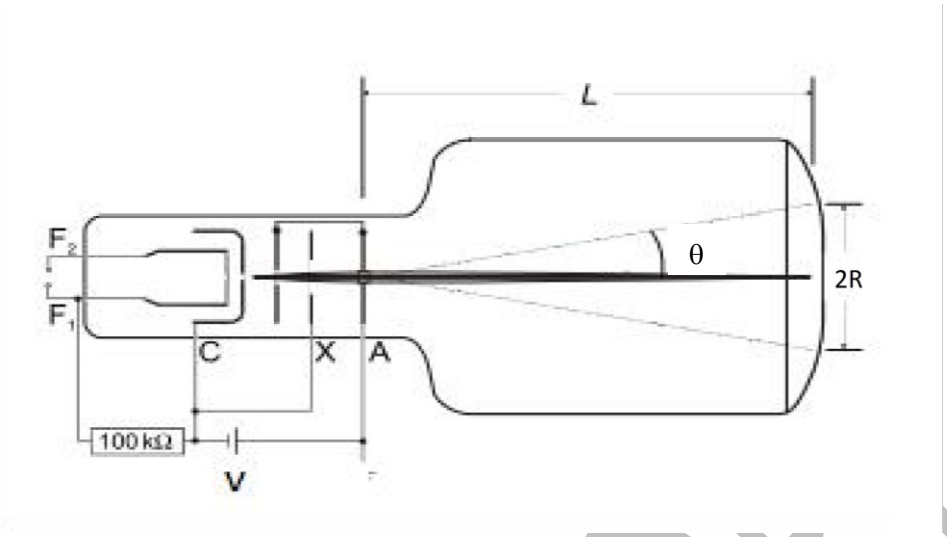

Fig. 1: Schematic sketch of the experimental setup.

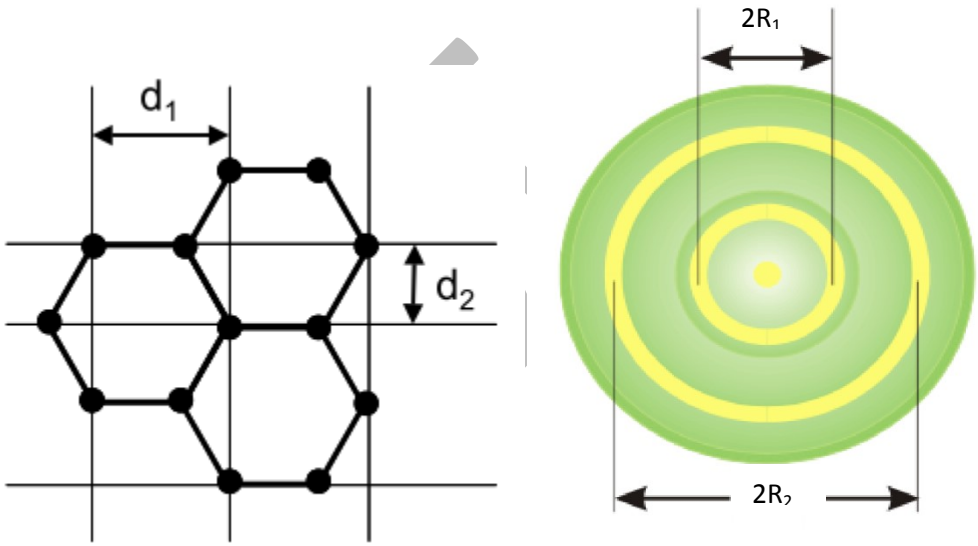

Fig. 2: (Left) Two independent types of lattice planes in polycrystalline graphite and (Right) the diffraction rings produced by these lattice planes. $2R_1$ and $2R_2$ are the diameters of the rings.

Safety guidelines and precautions

1. Never accelerate beyond 5 kV.
2. Never touch any controls on the power supply other than the 'On-Off' switch and the voltage varying knob.
3. Never use force to measure the ring diameters. Keep a **plastic scale** very gently over the tube to measure the diameters. **Metal scales are not allowed.**

4. **<u>You are working with a vey high energy source (> 5 kV) and hence touching any part of the entire setup other than what is mentioned in point 3 (just for the purpose of measurement) is prohibited. This is for your own safety and the safety of the lab.</u>**

Procedure

1. Set the accelerating voltage at 4 kV.
2. For the inner ring, measure the diameter ($2R_1$).
3. Fill up the radius (R_1) in the tabular column.
4. For the outer ring, measure the diameter ($2R_2$).
5. Fill up the radius (R_2) in the tabular column.
6. Calculate λ, sin θ and d from equations (2), (4) and (1) respectively and fill up the corresponding cells in the tabular column.
7. Repeat steps 2 to 6 for accelerating voltages 4.5 and 5 kV.
8. Calculate the average d for both inner and outer rings.

Tabular column

Ring	V (kV)	$2R_1$ (or) $2R_2$ (cm)	R_1 (or) R_2 (cm)	λ (Å)	sin θ	d (Å)
Inner	4.0					
	4.5					
	5.0					
Outer	4.0					
	4.5					
	5.0					

Average d for inner ring = …….. Å **Average d for outer ring = …….. Å**

Result

The interplanar spacings in graphite were measured as d_1 = nm and d_2 = nm.