Production Properties and Uses of X-rays

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Abstract— in this experiment we studied Bragg's scattering method on a crystal using an X-ray creator. Apart from high noise level error in experiment is low, which is ~0,7%. We observed two different beams with wavelengths 0,153 and 0,137 scattered at certain scattering levels which characterizes the crystal.

INTRODUCTION

After the invention of x-rays by Wilhelm Röntgen, Drag tried to form an equation for diffraction of x-rays from crystals. He prepares an experiment setup in which he sends x-ray to a sample, and measures intensity of X-rays scattered through at each angle from the sample. He develop an equation, $n \cdot \lambda = 2\, d \sin\theta$, in which he can specify the angles for which intensity of coming photons is high. Derivation of this equation is follows:

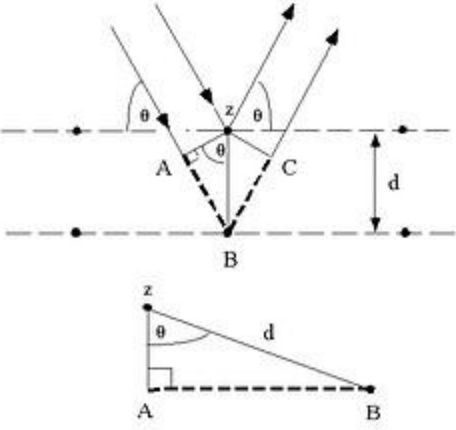

Figure 1

On Figure 1, to ensure that these two waves are in phase, the difference of their path, AB+BC should be integer multiple of the wavelength.

$$AB + BC = n\lambda \quad (1)$$

since $AB = d \cdot \sin\theta$ (2)

then $n \cdot \lambda = 2\, d \sin\theta$ (3)

which is Drag's law.

Usage of x-ray diffraction to reflect structure of crystals is based on this equation. While the direction of source is hold fixed in the experiment, both the direction of source and receptor is changed to determine the angles on which the intensity of reflected x-rays are high. Then knowing λ, θ; d, which is the separation of crystal layers, then structure, calculated easily.

EXPERIMENT

We used an instrument, Tel-x-ometer, which is closed to Figure 2 except the computer based part.

On experiment knowing θ and *d,* we try to calculate λ, wavelength of the x-ray beams.

Figure 2

We operated the machine on 30kV. We calculated the photons which are reflected by the sample via a counter for 10 seconds for the each angle from 10° to 120°. Figure 3 shows the resulting graph.

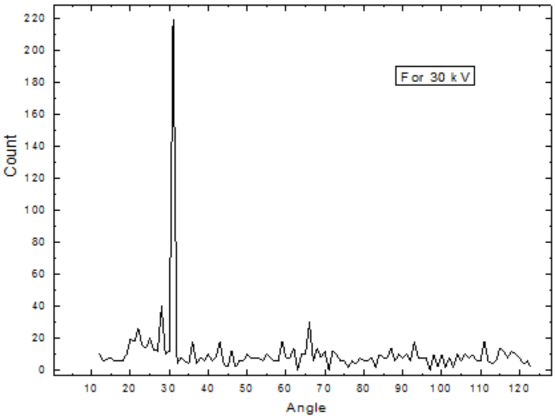

Figure 3

As expected, there is a sharp peak around 31° and also there are peaks at angles 28,59,66,93 and

111. We tabulated corresponding λ for these degrees on Table1.

Feature	2 θ	θ	sinθ	2d	nλ	n	λ
3	28	14	0,242	0,564	0,136	1	0,136
4	31	15,5	0,267	0,564	0,151	1	0,151
5	59	29,5	0,492	0,564	0,278	2	0,139
6	66	33	0,545	0,564	0,307	2	0,154
7	93	46,5	0,725	0,564	0,409	3	0,136
8	111	55,5	0,824	0,564	0,465	3	0,155

Table 1

According to Bragg, these peaks correspond to two radiations$K_{\beta,}$, K_α for each n. Taking the averages corresponding wavelengths appears to be:

$\lambda_{K_\alpha} = \ 0{,}153$ and $\lambda_{K_\beta} = \ 0{,}137$

For which the real values are, 0.154nm and 0.138nm, which means we had an error as 0,6% and 0,7% respectively. Although these results seem to be accurate, if the graph is considered, it is certain that noise is too much with respect to output values. Since we used a counter to count the photons; and the angles are accurately scaled, there should be only little error which was aroused from placing the sensor. These show that, noise is too much because of that instrument was not function as supposed to be. In other words generated photons are low from as ıt should be.

SUMMARY

In this experiment, we showed wavelike properties of electromagnetic waves. When they are in phase they we saw sharp peaks. Placement of atoms of a

crystal as layers also verified trough this experiment. Bragg's formulae and technique also verified.

Experiment is totally set on a instrument, therefore error is very low. However, due to a defect on x-ray producer noise level became high.

REFERENCES

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