X-Ray Diffraction: Analysis of Lipstick and Gunpowder Samples

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Where: Crime Scene
Only pieces of evidence
- Lipstick
- Gun Powder
NO DNA Samples
What should the investigators do?
X-RAY DIFFRACTION

Gunpowder
Not Your Everyday X-Rays

Common Usage of X-Rays
- Internal Structure of opaque Objects
- Medical Purposes
- Engineers
Not Your Everyday X-Rays

- **X-Ray Diffraction**
  - Determines the distance between planes of atoms in a compound
  - Chemical composition of samples
  - Determine the orientation of a single crystal or grain
  - Find the crystal structure of an unknown material
What Can They Be Used For?

Who is the manufacturer?

What was their processing batch?

Where were these products last sold?
Sir William Henry Bragg
William Lawrence Bragg
Shared Noble Prize in Physics in 1915
Determined crystal structures
- NaCl
- ZnS
- Diamonds

Bragg’s Law made it all possible
Constructive interference occurs only when

- $n\lambda = AB + BC$
- $AB = BC$
- $n\lambda = 2AB$
- $\sin\theta = AB/d$
- $AB = d\sin\theta$
- $n\lambda = 2d\sin\theta$
How X-Ray Diffraction Works

- Incident Beam
- Crystal
- Diffracted Beam
- Detector

X-ray source Mo
Wavelength = 0.07 nm

Specimen
Water
Thickness = 400.0 μm

Intensity of Transmitted X-rays = 96.08 %
How X-Ray Diffraction Works
How X-Ray Diffraction Works

X-ray Tube

Detector

Sample
Our Experiment

Goal
- To identify the contents of each of our samples

Samples/Preparation
- 3 Lipstick Samples
- 2 Distinct types of gunpowder
Our Experiment

- Philips X-pert X-ray Machine
  - Collection of data
  - Computer programs to analyze data
- Matching Peaks with International Center of Diffraction Data
- Compare our data with manufactures’
Results

Sample #39

Analyzing the Peaks

Intensity (Counts)

Two-Theta (Deg)
**These percentages are based on the normalized score.**
Results

X-ray Diffraction of Lipstick Samples

Differences in peaks
• The diffraction pattern of the gunpowder indicates a lack of crystalline character.

• Conversely, the black powder produced a graph with peaks, as we expected.
FBI Lipstick Database... COMING SOON?

Advantages of Using XRD at Crime Scenes

- The form and size in which crime samples occur
- The amount of material available
- The evidential restrictions to preserve the samples
- Used directly as a signature of the complex material
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