THE PROOF THAT DIAMONDS WERE MADE IN THIS LABORATORY

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You may be asking how we proved the crystals you have just seen are diamonds and that they were man made. For these crystals to be unmistakably identified as diamond, we had to show two things: (1) that they have a crystal structure identical with diamond, and (2) that, like natural diamond, they are composed of carbon. To prove they are man-made, the tests were repeated by others who were previously unfamiliar with this work.

Now I suppose to most people a diamond is something that sparkles and is said by a reputable jeweler to be a diamond. This is hardly a sufficient test, and besides, many perfectly good industrial diamonds are black and look more like cinders than diamonds.

The necessary, and possibly sufficient, proof for diamond is that its crystal structure, as determined from an x-ray diffraction pattern, be identical to that of diamond.

(Slide 1 — X-ray Method)

To obtain such a pattern, the specimen is placed in the path of a narrow beam of x-rays and rotated. The rays deflected by the crystal in certain characteristic directions are recorded on a photographic film. Let me explain this.

When you drive past a carefully planted orchard you see trees arranged in rows in certain critical directions. Just so, the atoms of a crystal line up in planes in various critical directions and spacings. While from the arrangement of the orchard rows you cannot determine whether it is a peach or an apple orchard, the arrangement of planes in a crystal is all an x-ray beam needs to decide what

the material is. The various planes deflect the x-ray beam in directions that are characteristic for each crystalline material, and the deflected rays are recorded on a photographic film.

(Slide 2 — Octahedra Model)

Now a pure diamond is composed of carbon with its atoms arranged as you see them here.

(Slide 3 — Octahedral Crystals)

Diamonds are frequently found as octahedral crystals, but they are also found in an infinite variety of external shapes. The point is that inside the diamond, regardless of its external appearance, the atoms are arranged just as they are inside this octahedron.

(Slide 4 — X-ray Pattern of Single Crystals)

This internal arrangement of the carbon atoms, <u>not the external appearance</u>, produces the characteristic x-ray diffraction pattern. At the top is the pattern for a man-made diamond and beneath is the pattern for a natural diamond. The important things here are the diameters of these rings on which the spots lie and the number of rings. These are x-ray patterns of single crystals of appreciable size.

X-ray diffraction patterns are as characteristic of crystalline materials as fingerprints are of people. Just as out of millions of specimens of fingerprints no two are alike, so out of tens of thousands of x-ray patterns of different materials, only diamond produces these patterns. The material giving the pattern most nearly resembling diamond is a rare form of silicon carbide and in this case the spacing of the rings is so different that a mistaken identity is out of the question.

(Slide 5 — Chemical Analysis)

As convincing as the x-ray pattern may be, we have nevertheless made other tests. Chemical analysis showed the crystals to be composed of 85 to 86 per cent carbon and 14 to 15 per cent non-combustible inorganic ash visibly entrapped in some of the growing crystals. Natural diamonds range in carbon analysis from pure 100 per cent carbon diamonds down to 80 per cent carbon and 20 per cent non-combustible inorganic ash trapped within the crystal as it grew.

These crystals therefore have the crystal structure and chemical analysis characteristic of diamond.

Are they as hard as diamond? Can they scratch all other materials, including diamond, the same as natural diamond does?

(Slides 6, 7 — Scratches in Boron Carbide and Diamond)

Yes, they can. These man-made crystals will scratch natural diamond and all of the hardest known materials.

Will they refract light like natural diamonds? Yes, they will. Their index of refraction was determined to be between 2.40 and 2.50. The index of refraction for natural diamond is 2.42.

(Slide 8 — Index of Refraction of Minerals)

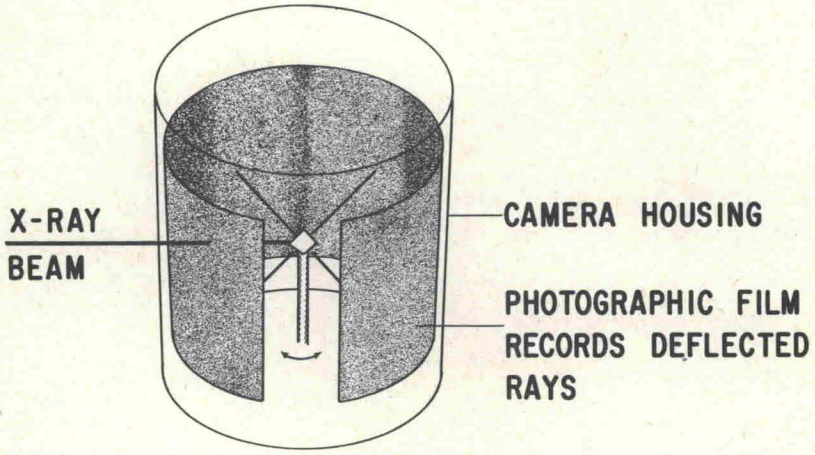
There are only five minerals listed having an index in or near this range, including diamond. Only three of them are hard enough to scratch glass, franklinite, perovskite, and diamond. Franklinite and perovskite are eliminated by the x-ray and chemical tests.

The final crucial question is: Are these crystals we have shown you and that pass all of the physical and chemical tests for diamond man-made? We have answered this in the best way we know; others in the Laboratory not previously familiar with this work made them, too. These people were shown how diamonds were made. They then procured all of their own raw materials and holders for the samples. Following the instructions given, they made their own diamonds, which were identified by x-ray diffraction patterns. These people have demonstrated that the diamond-making process described to them makes diamonds.

(Slide 9 — Summary)

In view of the identity of the crystal structure with diamond, as shown by x-ray, chemical analysis, the hardness and optical properties and the repeatability of the process, we can only conclude that the crystals we have made in this laboratory are indeed diamonds.

DIAMOND CRYSTAL SHOWN MOUNTED IN MIDDLE OF A CYLINDRICAL X-RAY CAMERA



CHEMICAL ANALYSIS

	% CARBON	% ASH
MAN-MADE DIAMONDS	85-86	14-15
NATURAL DIAMONDS	80-100	0-20

COMPOSITION OF NONCOMBUSTABLE INORGANIC ASH FOUND IN NATURAL DIAMONDS: SiO_2, Fe_2O_3, CaO, MgO, Al_2O_3 AND TiO_2

INDEX OF REFRACTION AND HARDNESS NUMBER OF FIVE MINERALS

		INDEX OF REFRACTION	MOHS'S HARDNESS
FRANKLINITE	$(Zn, Fe, Mn)O \cdot (Fe, Mn)_2O_3$	2.36±	6
PEROVSKITE	$CaO \cdot TiO_2$	2.38±	5.5
DIAMOND	C	2.419	10
SPHALERITE	(Zn, Fe) S	2.428	3.5-4
EGLESTONITE	Hg_2Cl_2, Hg_2O	2.49±	2-3

SUMMARY OF TESTS ON MAN-MADE DIAMONDS

1. CRYSTAL STRUCTURE – identical to diamond by X-Ray Diffraction
2. CHEMICAL ANALYSIS – composed of Carbon (Natural Diamonds are carbon)
3. OPTICAL PROPERTIES – Has same index of refraction as diamond
4. HARDNESS – hard as natural diamond
5. REPEATABILITY – Process was repeated independently by other people