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Diamonds which were not forever

One hundred years ago an obscure Scottish chemist James Hannay created diamonds

One hundred years ago on 20th February, 1880, Professor Nevil Story-Maskelyne Keeper of Minerals at the British Museum, announced that an obscure Scottish chemist, James Ballantyne Hannay had succeeded in mnufacturing diamond.

Ever since Smithson Tennant had discovered in 1797 that diamond is a crystalline form of carbon, alchemists had searched for methods which would convert inexpensive forms of carbon into the most prized of gemstones.

Many frivolous and unsubstantiated claims of success rapidly followed and were quickly dismissed but the methods used by Hannay had the ring of authenticity about them.

Mr Hannay recognised that since natural diamonds are probably formed under geological conditions of high temperature and high pressure, these conditons would be necessary to manufacture diamond in the laboratory.

He had been working for some time on the decomposition of hydrocarbons at high temperatures and in the presence of certain metals, into hydrogen and carbon, and concluded that at sufficiently high pressures the carbon would be deposited as diamond.

In a series of particularly hazardous experiments he sealed a mixture of bone oil paraffin and lithium into wrought iron tubes and heated them to red heat in a furnace for 14 hours.

On more than one occasion the furnace was completely demolished as the iron tube exploded but he persevered with his experiments and eventually claimed that three out of more than 80 attempts were successful.

Mr Hannay sent 12 of the tiny crystals recovered from his apparatus to Story-Maskelyne who positively identified them as diamond.

Fourteen years later the French chemist Henri Moissan claimed success by a completely different technique. He dissolved carbon in molten iron, using an electric furnace, and then rapidly quenched the iron in water.

He believed that the solidification of the iron from the outside exerted as enormous pressure on the still-molten core, causing the carbon to crystallise as diamond.

In an exhaustive series of investigations at the beginning of this century Sir Charles Parsons attempted to duplicate the methods used by Hannay and Moissan. Although some small hard crystals were produced he eventually concluded that none of these was diamond, and that the claims made by previous workers could not be substantiated.

The Hannay diamonds are unique in that they are the only known surviving examples of the early claims to have synthesized diamond The nine remaining samples a few tenths of a millimetre across, are still held by the British Museum. In 1943 Bannister and Lonsdale examined the Hannay specimens using X-ray crystallography and confirmed that all but one were indeed diamonds.

From their measurements and other evidence, they concluded that these diamonds had been made by Mr Hannay. Others maintained that since his results could not be reproduced they should not be accepted.

Three quarters of a century was to pass. following Mr Hannay's announcement of success, before the undisputed synthesis of diamond by the Swedish firm Allmanna Svenska Elekriska Aktiebolaget (ASEA) and independently by General Electric (GE) in America.

Although GE announced the results of their work in 1955, it was not until 1960 that secrecy orders permitted ASEA to claim that they had first produced diamonds in 1953. The minimum conditions necessary for diamond synthesis require pressures around 45 000 atmospheres (300 tons per square inch) and temperatures around 1,200°C to be maintained simultaneously for several minutes.

These conditions could not possibly have been achieved by Hannay or Moissan but the apparatus designed by Tracy Hall of GE was well able to withstand this formidable combination, and still forms the basis of modern diamond 'presses'.

Since the announcement of successful diamond synthesis by GE, several scientists including the author have reexamined the Hannay diamonds using a variety of experimental techniques and have concluded that they are all fragments of natural diamond. How these found their way into the Hannay apparatus is still open to speculation.

Today, synthetic diamonds are produced on a world wide basis, principally by GE and the De Beers organization, and it is estimated that two-thirds of all abrasive diamonds used are now man-made.

Although generally small and unattractive (the largest commercially produced crystals are about 0.75 mm across) synthetic diamonds are ideally suited to many industrial cutting and grinding applications.

A batch of industrial diamonds is normally grown in a few minutes but within the last decade GE and De Beers have shown that it is possible to produce large (5mm. 1 carat) diamonds, some of gem-quality by extending the growing time to about a week.

The cost of manufacturing gem-quality diamond is uneconomic, but as the technology of diamond synthesis improves and the cost of mining natural stones increases, man-made diamonds may well penetrate the gem market.

It is interesting to look back and see that the early experimenters were basically on the right track High temperature, high pressure and a solvent metal are essential features in present-day synthesis.

Mr Hannay and his contemporaries were limited by the high temperature high pressure by the limited technology of their day, but their vision and alleged successes almost certainly acted as a spur towards the eventual solution of the problems surrounding the quest for man-made diamonds.

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