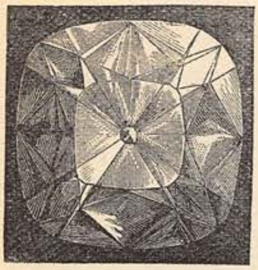
HOW ARTIFICIAL GEMS ARE MADE.



GREAT was the excitement among the famous jewellers of Paris when it was first announced that MM. Fremy and Feil had discovered a method of making rubies, sapphires, and Oriental emeralds in fabulous quantities. For awhile they consoled themselves with the reflection that the real stones would always have the advantage over the artificial; but the excitement increased when it became known that the manufactured gems were no imitations, but were absolutely identical with the productions of nature.

Some people thought that Government ought to interfere and forbid the manufacture, while others indulged in fond expectations that now at last the dreams of the alchemists would be realised, and that when gold and diamonds could be made wholesale, all the poverty and most of the misery of the world would cease. With regard to the diamond, we shall have a word to say presently; but as for gold and the other metals, the majority of modern chemists consider them as simple elements, which, though, changing their form and capable of various combinations, are still intrinsically the same, and cannot therefore be produced from any other substances. It is quite a different matter with precious stones, most of which—even those which we prize most highly—are in the eyes of the chemist of very humble origin. The ruby, sapphire, and emerald, and many others are simply clay, or rather alumina, crystallised; while the diamond is closely related to the soot which collects in our chimneys. Others, again—such as the common emerald, aquamarine, chrysoberyl, and jacinth—contain earths nearly related to alumina, as "beryl-earth," or glucina, and "zircon-earth," which are in themselves so little rare or valuable that in some places the poor relations of the emerald are used to pave the streets.

In fact, all precious gems, diamonds and pearls included, are for the most part composed of very common materials—such as alumina, silica, carbon, lime, magnesia, &c.—which we are accustomed constantly to see in other forms. The only advantage possessed by the precious stone is that the common material of which it is composed has crystallised in an uncommon way, its rarity as well as beauty constituting its value. Having therefore ascertained the chemical composition of a sapphire or ruby, if we can induce the various elements to combine and crystallise, we shall have, not imitation stones, but real ones artificially produced. They are as real as the ice made by an artificially lowered temperature, or the chickens produced by an incubator; but after all we cannot be said to *make* them, for we but give them the opportunity and necessary conditions of making themselves.

Chemical combinations and simple substances crystallise when they pass from the liquid or gaseous into the solid state. The most familiar example of crystallisation is that of water, which becomes ice at a certain temperature. Water impregnated with salt and allowed to evaporate will deposit salt-crystals; and if a sufficient quantity of alum be dissolved in hot water and left to cool, it will be deposited in small, transparent, eight-sided crystals, which will *continue to grow* until they attain a large size, if left perfectly quiet, where the water can evaporate slowly. Any impurities or admixture the alum may have contained will remain behind in the vessel as sediment, for crystallisation is generally accompanied by purification. Many precious stones have apparently been formed in this sort of way, as well as most of the less valuable ones, such as rock-crystal, agate, jasper, opal, chalcedony, chrysoprase, cornelian, blood-stone, amethyst, cairngorm, and onyx, which consist mainly of silica, of which the common flint is an impure variety.

At the same sitting of the Paris Academy in which MM. Fremy and Feil announced their discoveries, M. Monnier said that he had obtained opals by pouring a weak solution of oxalic acid on a strong solution of silica and soda, by which the silica was made slowly to crystallise. The introduction of sulphuric acid and protoxide of nickel gave a green crystal like the chrysoprase. Another method of crystallisation is that of the slow cooling of melted minerals. Take a crucible containing melted sulphur or bismuth; let it cool slowly until a crust is formed on the top; make a hole in this, and pour out part of the liquid, and the sides of the hollow thus formed will generally be covered with very fine crystals, the whole looking like a crystal druse, such as amethysts and other half-precious stones often form.

At some time or other in its history, this earth seems to have been in a state of fiery fusion, when all its elements were mingled together in chaotic confusion, and formed the most wonderful combinations. The whole earth in fact was a gigantic laboratory, and the metals played the part of pigments, now sustained by the aniline combinations. But for them the precious stones would have been all alike, and for the most part as colourless as water; it is to the metals they owe their brilliant hues. Rubies and emeralds are both apparently tinted with chromium, the sapphire with cobalt, lapis lazuli with a combination of iron, others with copper, nickel, and manganese.

The really beautiful *imitation* stones made in Paris consist of a very pure, transparent, and lustrous glass, called Strass after its inventor, which is frequently coloured with the same metallic oxides as real precious stones. Thus the colour of the topaz is obtained from antimony and gold; that of the ruby from purple of Cassius (a stannate of tin, with stannate of oxide of gold), or from a solution of gold in aqua regia (nitro-muriatic acid). The well-known Bohemian ruby-glass is coloured with gold, while the ordinary red glass is produced by copper, and a commoner kind by iron. Some of the finest yellow glass is coloured with silver. The first precious stone to be successfully produced by artificial means was the lapis lazuli, the sapphire of classical times, but by no means to be confounded with the sapphire of the modern jeweller, though closely related to it. Lapis lazuli is an *opaque* stone, of an exquisite corn-flower blue, and was highly prized by the ancient Indians, Assyrians, Persians, Jews, Egyptians, and Greeks. Freed from impurities and rubbed down, it gives the ultramarine used by mediæval artists for the robes of their Madonnas; and in their day it was worth its weight in gold, the purchaser of a picture having always to pay extra for its use. Its rarity and the cost of preparation make the true ultramarine still worth from 10s. to 50s. the ounce.

The ruby and sapphire were the next to attract attention. Several decades ago, a chemist named Gaudin succeeded in obtaining little balls of a ruby-red by melting together pure clay and a solution of chromate of lime, the colour being more or less intense, according to the quantity of chromium used. These balls were so hard as to scratch glass, topaz, and garnet with ease, but they were not crystals, and they were not as transparent as might be wished. Many other chemists made similar attempts, with more or less success. The great thing to be aimed at was evidently the crystallisation of the alumina or beryl-earth; and for this purpose it was necessary that it should be melted, mixed with the colouring metals, and allowed to cool very slowly. The best medium for melting the clay appeared to be boracic acid, which was heated with it in a platinum crucible for a considerable time. As it evaporated, small rubies, sapphires, or emeralds were formed; but their size was too insignificant to make the process remunerative. M. Fremy's new attempts have been, however, much more successful, and proceed on a rather different plan. All clay, even the purest, is a silicate of alumina, this earth being nowhere found pure in a natural state. Taking kaolin, or china clay, the purest of all, which contains from 42 to 48 per cent. of alumina, M. Fremy mixes with it an equal quantity of red lead, and then exposes it to an intense heat for several weeks. The lead not only attracts to itself the silicic acid contained in the clay, but even that of the earthenware crucible, into which it eats its way to such an extent that, in order to prevent loss, it is necessary to place the first vessel in a second. When at last it is allowed to cool, the crucible is broken, and its contents are found in two layers, the upper one glassy, and consisting mainly of silicate of lead, while the lower is crystalline, and contains most perfect crystals of alumina. If nothing but clay and red lead have been used, they are perfectly colourless, but will scratch glass, rock-crystal, and topaz, and are in fact specimens of the precious corundum called diamond spar, because it is next in hardness to the diamond itself. By the addition of two or three per cent. of chromate of lime, the corundum acquires a lovely rose-colour, and becomes a ruby, while a trace of the chromate and a small quantity of oxide of cobalt convert it into the sapphire.

Until quite recently it seemed that, though other gems might be conquered, the diamond would still vindicate her claim to her ancient title of Adamas, the Invincible or Untameable, but it is so no longer. Everybody has known for some time that the transparent diamond was only a peculiar form of crystallised carbon, but the great difficulty which has hitherto baffled all the chemists, has been that of finding some means of dissolving or vapourising this intractable substance, which refuses to melt in the hottest flame and resists the action of acids, alkalies, alcohol, and ether; and though it dissolves in molten cast-iron, is so perverse as to crystallise in the form, not of diamond, but of plumbago or blacklead. It has hitherto been supposed that liquids were the only solvents, but Mr. Hannay and Mr. Hogarth of Glasgow, the successful diamond-makers, found that when alcohol in which potassic iodide had been dissolved was heated above the "critical point," at which it ceases to be a liquid and becomes gaseous, the iodide, instead of being precipitated in the solid form, as they expected, remained in a state of solution or diffusion in the gas. Moreover, a fragment of iodide was dissolved by the gas alone, without coming in contact with the liquid at all. When the gas was suddenly released from pressure, the iodide was deposited in the form of a cloud of snow-white crystals like hoar-frost, which were redissolved when the pressure was increased; and as Mr. Hannay found that a solid when freed from its gaseous solvent was invariably deposited in a crystalline form, he considered that carbon might be induced to dissolve and crystallise in a similar way. On making the attempt, however, he found that plumbago, charcoal, and blacklead still refused to yield to the most probable solvents, even when these were brought to their critical points. Next he bethought him that substances which refuse to combine under ordinary circumstances, will do so readily in the "nascent" state—*i.e.*, at the moment when they are liberated from some other combination; and he found that when a gas containing both carbon and hydrogen is subjected to heat under great pressure, and in the presence of certain metals, the two part company, the hydrogen being attracted to the metal, and the carbon left free. After attacking this nascent carbon with various gaseous solvents, Mr. Hannay succeeded in dissolving it; and, when the pressure was reduced, he had the triumphant satisfaction of seeing the carbon deposited in the form of minute transparent crystals, having all the characteristics of the true diamond. At present the cost of producing them is twenty times that of their market value.

Whether Nature's diamonds have been formed in a way similar to Mr. Hannay's is doubtful; it may be that she, with her unlimited resources, does not always confine herself to one method; but an eminent chemist has recently said, "We are entirely ignorant of the mode of the diamond's formation in nature. The only thing which may be regarded as certain is that it has *not* been formed at a high temperature."

S. GAYE.