Methods of Producing Synthetic Alexandrite

Both melt and flux techniques have been used to produce synthetic alexandrite. Most synthetic alexandrite is produced by the Czochralski or the floating zone method.

Melt techniques for alexandrite

Czochralski´s pulling method

Czochralski pulling technique

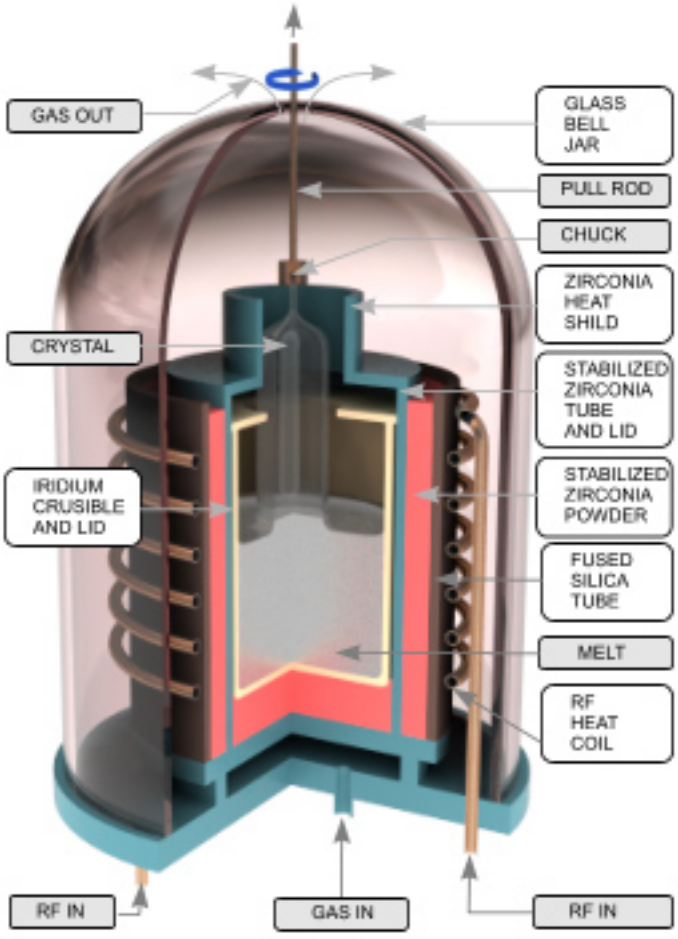

Fig. 22.: Schematics for the Czochralski-pulling technique for growth of single crystal rods of high-melting oxides and other materials, directly from the melt.

See Alexandrite Tsarstone collectors guide, Methods of Producing Synthetic Alexandrite, http://www.alexandrite.net/viewpage.html?id=ALXS-002-00011 (Information about melt and flux techniques used for the synthetic alexandrite manufacturing) (as of).

In 1916, Jan Czochralski (1885 -1953), a Polish chemist, developed a new method for synthesizing rubies. Known as crystal pulling, this is a fast and effective method of producing nearly flawless stones from a melt. When cut as gems the stones are so clear that they look like glass imitations.

Czochralski discovered his method when he accidentally dipped his pen into a crucible of molten tin rather than his inkwell. He pulled his pen out to discover that a thin thread of solidified metal was hanging from the nib. He replaced the nib by a capillary, and verified that the crystallised metal was a single crystal. His experiments produced single crystals of a millimetre in diameter and up to 150 centimetres long. Czochralski published a paper on his discovery in 1918. In 1950, G.K. Teal and J.B. Little from Bell Labs in the USA used this method to grow single germanium crystals which later led to their large scale production for semi conductor applications.

Today the Czochralski pulled-growth method is used to make ruby, sapphire, spinel, yttrium-aluminum-garnet (YAG), gadolinium-gallium-garnet (GGG), and alexandrite. The ingredient powders are melted in a platinum, iridium, graphite, or ceramic crucible. A seed crystal is attached to one end of a rotating rod and the rod is lowered into the crucible until the seed just touches the melt. The rod is then slowly withdrawn. The crystal grows as the seed pulls materials from the melt, and the material cools and solidifies. Owing to the surface tension of the melt, the crystal stays in contact with the molten material and continues to grow until the melt is depleted. Crystals formed with this method can be very large, -- more than 50 millimetres in diameter and one metre in length with a high degree of purity. Although Czochralski pulled boules are much more expensive than flame fusion boules to produce, their cost is still a fraction of the natural materials that they imitate.

Floating zone

This method is similar to the Czochralski method, but the crystal is pulled horizontally instead of vertically, using a tungsten dish and slow-melting techniques, where the dish is pulled over a period of time under a heating element. The length of time depends on the size of the dish and the materials being crystallized. Alexandrite forms at about two mm/hour. This method was developed by an Armenian scientist, Professor Bagdosarov of the Institute of Crystallography of Russian Academy of Sciences in the 1970s.

Solution techniques for alexandrite

The flux method

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The flux process

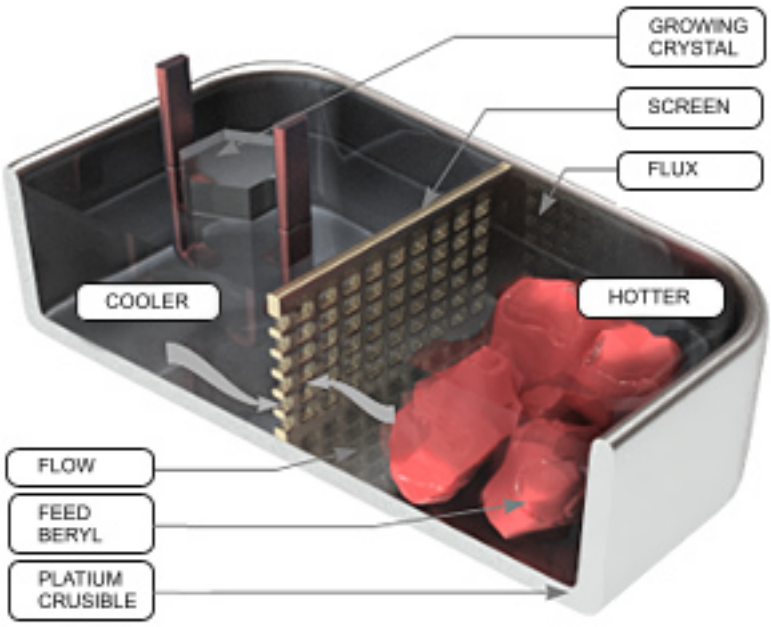

Fig. 23.: Schematics for the flux growth of chrysoberyl. The latter dissolves in the flux and regrows as a single crystal on the seed.

The flux process, was originally pioneered by Tom Chatham in the U.S.A. Flux is any material that when melted dissolves another material with a much higher melting point. The process utilizes powdered chemicals of the correct composition and adds a liquid solution to dissolve the compound before super heating. While dissolved in the flux, molecules can travel freely and attach themselves to a growing crystal. Some manufacturers immerse seed crystals in the solution, and others allow the molecules to combine randomly and form an unplanned number of crystals. The temperature is maintained for three to twelve months and very slowly cooled mimicking nature's processes. Some manufacturers then pour off the molten flux to expose the crystals. Others cool the material slowly and extract the crystals by breaking off the solidified flux or dissolving it in acid.

Gemstones crystallized by flux processes often contain remnants of undissolved flux and this material can look very much like the inclusions in natural gemstones. With experience, gemologists can differentiate between flux and natural gemstone inclusions and use this information to determine the origin of the material under study.

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Commercial productions of synthetic alexandrite

Most synthetic alexandrite is manufactured in the Russia, Japan, and the USA. Synthetic alexandrite gemstones were first produced in 1973 by Creative Crystals of San Ramon California. Both crystal pulling and flux growth techniques were revealed in patent assigned to Creative Crystals in 1975.

Kyocera of Kobe Japan also produced small quantities of alexandrite under the name "Crescent Vert Alexandrite" which was marketed in the USA under the name "Inamori Created Alexandrite . Seiko Corp has also produced alexandrite by the floating zone method.

Novosibirsk (Russia) has been a center for research into the production of synthetic gems. In 1980, Alexandrite was produced using the flux method. Later in 1995 another flux grown synthetic alexandrite introduced. The cut stones showed prominent growth zoning as closely packed parallel lines. Some had an intense red core with a lighter red rim and there was an intense red boundary between them. Hexagonal outlines were also reported from a large number of crystals from these Russian stones.

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