Article:

The Hydrothermal Method is a widely used process for crystallization of minerals and synthetic crystals for both material science and gemology. The process involves sealing aqueous ingredients and a suspended crystalline seed in a high-pressure high-temperature autoclave. The autoclave is heated until the ingredients are able to evaporate and surround the seed crystal. The chamber often contains a temperature gradient, with the cooler end being towards the top of the chamber near the seed. This temperature gradient attracts hotter vapor from below to carry ingredients to the seed crystal. Over a span of time (often weeks or months), large monocrystalline ingots can slowly be formed. These ingots are eventually removed from their crucibles and then sliced along their vertical axis to separate the seed from the two faces of the crystal. These thicker faces can then be polished or sliced into various shapes depending on the exact use case. Typically, they are sliced into flat substrates for use as piezoelectric crystals or growth substrates for other materials like semiconductors and exotic crystals.

For specific materials, quartz makes up the majority of modern usage for the process. It is mass produced using this method for material research, as well as for industrial and commercial usage. Other materials such as synthetic corundum, beryl, and chrysoberyl can be grown using this method, but may form with impurities or defects in the crystal structure. This makes them more appealing to the gem industry, as the defects better resemble natural specimens. However, combined with expenses and extended growth periods, hydrothermal synthesis has been largely phased out by other methods which produce higher quality materials in less time. Beryl has been the one exception to this rule, as it is still one of the few methods used at scale for producing synthetic emerald and other beryl varieties for the gem industry.

History:

Hydrothermal synthesis has been understood since long before artificial recreations of the process. Geologists understand it as a natural process that can form pegmatites, the natural process is also where the name of the synthesis method is derived. Many of the pegmatitic minerals first found in nature are the very same ones we now produce artificially using this process. The oldest report of artificially growing crystals using the hydrothermal process date back to 1845; German geologist Karl Emil von Schafhäutl published a report regarding microscopic quartz crystals, of which he produced within a pressure cooker. Multiple scientists and companies have since refined and developed this technique. Today there are multiple variations of the process, but the initial technique has been mostly unchanged. It is still among the most heavily relied-upon methods for crystal synthesis in the modern world.