The Alexandrite Laser

The invention of lasers was one of the most significant developments in science and engineering. Lasers were developed to isolate and emit specific wavelengths of light that could be used for a multitude of scientific and medical purposes.

The ruby laser takes its place in history as being the first working laser to be demonstrated. In 1960, Theodore Maiman built the world's first laser at Hughes Research in the USA. Maiman's device used a synthetic ruby to harness the energy released from the excitation and consequent relaxation of chromium electrons in the crystal. Ruby emits its principal laser energy at a wavelength of 694.3 nm.

Lasers are so effective because they can precisely control the light they emit. In terms of time, energy levels, wavelength, pulse duration, line width, active area, spontaneous life time, and beam diameter the laser is the optimal tool for controlling light emission. Applications that require a specific character, level, and duration of light energy emission employ lasers to fine tune the output.

Today, hundreds of different lasers are available but only a few types are regularly used. Although synthetic alexandrite is widely used for jewelry, it is predominantly used as a laser. Alexandrite lasers were initially researched and developed by AlliedSignal Corp. (The merger of Honeywell Inc. and AlliedSignal takes place in 1999.) The company invested over $100 million in developing alexandrite laser systems and in the growth of high-quality laser material. They were first developed for military and government applications.

These lasers have more recently become useful in removing hair, tattoos, and visible leg veins. Alexandrite lasers can also be used for etching, drilling, marking metals, metal coatings, and ceramics. Some diode-pumped alexandrite lasers are used in CD mastering, blood-flow cytometry, confocal microscopy, and fluorescence diagnostics. It is interesting to note that synthetic alexandrites containing only very small quantities of chromium with a pale color change are most effective for use as lasers.

The alexandrite laser was originally designed to be a fixed wavelength laser, but later was developed into a tuneable solid-state laser. Alexandrite rods are usually 0.3 to 0.7 cm in diameter and 7.6 to 10 cm long. Alexandrite lasers can be pulsed or continuous, depending on the requirements of the operation. The majority of medical lasers devices only deliver one wavelength of laser light, and the surgeon has to choose the right wavelength for the tissue involved. Some lasers can deliver two wavelengths of laser light but some are tuneable over a narrow range of wavelengths. Continuous wave lasers emit a steady beam for as long as the laser medium is excited. If this beam is held on tissue longer than the thermal relaxation time, excessive heat will be conducted into normal tissue delaying healing and increasing scarring. All continuous wave lasers may be pulsed, either mechanically or by electronic or photonic means.

Alexandrite lasers for hair removal were cleared by the FDA to market in the USA in 1997. Until recently, shaving, plucking, waxing, and electrolysis were the only methods of removing unwanted hair. The first reports of using laser energy to remove hair were published in the early 1990s. Lasers have now become the standard for managing unwanted hair.

Laser hair removal systems work using the principal of selective photothermolysis, in which a carefully timed pulse of laser energy passes through the skin and is absorbed and converted to heat energy at the hair follicle. The most common lasers used are the ruby, alexandrite, diode, and YAG lasers. Not all hair removal lasers are equally effective for a given combination of skin and hair colour. Shorter wavelength lasers such as ruby and alexandrite are highly absorbed by melanin, and can deliver more energy to lighter finer hairs. However, with more absorption by skin melanin, the risk of blistering is increased.

The ruby laser is the original hair removal laser. Its deep red color is well absorbed by the melanin pigment in hair, making it a good choice for fine and light hair. However, because melanin is also present in the skin the ruby laser cannot be used on patients with darker skin.

The alexandrite laser, with its large spot size and high repetition rate has now usurped the role of the ruby laser. It is the fastest most widely used laser for hair removal and is suitable for rapid treatment of large body areas in patients with light to olive complexions and an entire back can be treated in less than thirty minutes. Not only is alexandrite tuneable but, cosmetic alexandrite lasers are a fraction of the size of the ruby devices.

Modern lasers allow the removal of most tattoo inks with a low risk of scarring. Alexandrite lasers can significantly lighten or remove many tattoo inks, and are especially effective for removing green and black inks. Tattoo ink is removed by using a specific wavelength, which passes through the skin but is absorbed by the ink. The rapid absorption of light energy destroys the tattoo ink so that it can be removed by the body's natural filtering systems. With the correct combination of wavelength and rapidly pulsed light, the ink can be removed with minimal damage to the skin.

Alexandrite lasers are also used for treating kidney stones and require very little maintenance and are unlikely to harm the patient.

See Alexandrite Tsarstone collectors guide, The Alexandrite Laser, http://www.alexandrite.net/viewpage.html?id=ALXS-002-00013 (Synthetic alexandrite predominantly used as a laser and was initially developed for military and government applications) (as of).