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Lab-created precious stones – the gemstones of the future

Introduction –

LifeGem Diamonds Limited offers lab-created precious and semi-precious gemstones such as Emerald, Alexandrite, Ruby, Chrysoberyl, Spinel & Forsterite (Tanzanion and Peridot).

Gemstones are generally classified as -

a) Naturally occurring gemstones –

Most of the naturally found gemstones are very expensive. For example, good quality Alexandrite costs Rs. 6 lakhs per carat, Emerald costs Rs. 2 lakhs per carat and Ruby costs Rs. 50,000 per carat. Many buyers cannot afford these natural gemstones and as a result, the lab-grown gemstone industry started in 1960's.

b) Treated natural gemstones –

Most of the natural gemstones available in the market are treated, irradiated or dyed to improve the colour, clarity & appearance. They are 'glass-filled' or 'fracture-filled' to intensify the colours. Treated gemstones lose their shine and colour after some time, as they are boiled with lead and other additives for colour treatment, which is not permanent.

Lab-created gemstones are 'as-grown' and not 'colour-treated'. They are much superior to treated natural gemstones.

c) Lab-grown gemstones –

People have loved the look of gemstones in their jewellery for centuries. Whether it is a necklace or a bracelet covered in rubies, emeralds, spinels and alexandrites, these bright stones continue to be loved for their beauty and style. Unfortunately, the rarity and price of many of these gemstones make their purchase out of reach for numerous people. Today, scientists are able to create these precious gems in a lab, making them significantly more accessible to buyers.

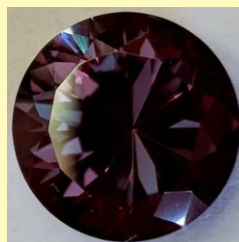
The more expensive and hard-to-find natural gems in jewellery, such as Emerald, Alexandrite & Ruby are the favourite lab-created stones. They are not gem imitations; lab-created gemstones are real. They are grown in a laboratory, but are identical physically, chemically and optically to natural gems. An imitation gemstone, which is also man-made such as cubic Zirconia (CZ), does not follow nature's recipe, so it is completely different physically, chemically and optically from the natural gem it copies.

In the laboratory, precious stones can be made by using different processes, as under -

- 1) Czochralski crystal pulling (growing process)
- 2) Flux (growing process)
- 3) Verneuil Flame Fusion (melting process)
- 4) Hydrothermal (crystallisation process)

LifeGem uses Flux process for growing Emerald and Czochralski process for growing other gemstones like Ruby, Alexandrite, Spinel, Chrysoberyl, Forsterite, etc.

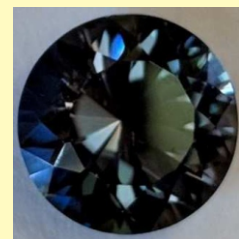
LifeGem lab-grown gemstones



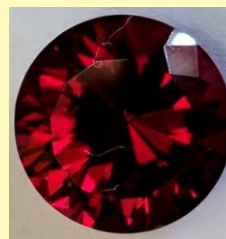
Colour-changing Alexandrite



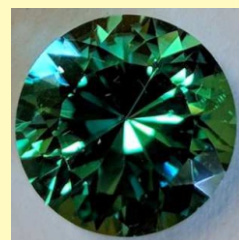
Emerald



Tanzanion



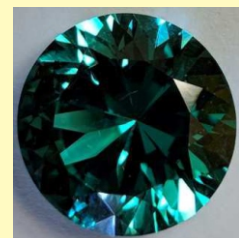
Ruby



Peridot



Sky blue Chrysoberyl



Aquamarine Chrysoberyl



Red Spinel



Sky blue Spinel



Blue spinel

The mineral composition of natural gems is re-created through a process, similar to the way that nature forms gems deep beneath the surface of the earth. Rather than waiting for the earth to complete the natural process, scientists can grow these gems in the laboratories in several weeks.

Lab-created precious stones – the gemstones of the future –

LifeGem created gemstones have the same luster, fire, shining, quality, endurance & chemical composition of the best quality natural gemstones, but they are much cheaper.

Lab-grown gemstones are created in a controlled laboratory environment and hence the colour comes out richer and more even. In terms of colour saturation and clarity, lab-grown gemstones are arguably more beautiful than their natural counterparts.

The main difference between the two types of stones is that natural gems typically have flaws. Lab-created gemstones rely on a steady process of heat and pressure that result in nearly flawless stones. The average person cannot see these differences, but a trained gemologist can see under high magnification.

It is important to note that lab-created gemstones are not imitations of gems. These stones are created in labs with identical chemical, physical & optical characteristics of naturally occurring gemstones. This means that the mineral composition of these lab-created gems is re-created through a process similar to the way that nature forms the gems.

For making lab-grown gemstones, the constituents are dissolved in a melt or solution at high temperatures and the crystal forms initially on a seed crystal, as the melt temperature is lowered. Following table gives the comparison between various methods of gemstone creation –

Comparison between various methods of gemstone creation

	Czochralski crystal pulling process ✓	Flux process ✓	Verneuil flame fusion process ✗	Hydrothermal process ✗
Description	Invented by Jan Czochralski and commercialized in the 1960's.	Invented by Tom Chatham in the 1930's.	Invented by A.V.L. Verneuil & commercialized in the 1900's.	Developed in the 1960's.
Features	1. Most efficient and progressive method for obtaining high-quality & nearly flawless stones. LifeGem uses rough stones made from this process for Ruby, Alexandrite, Spinel, Chrysoberyl and Forsterite. 2. Mature technique with high optical & structural quality of gems; with uniform colouring along the whole crystal. 3. Rather expensive, as the crucibles are made of precious metals like Iridium. Growth rate is lowered to suppress the bubbles; it takes 2-3 weeks for crystal growth. 4. The process can grow single crystals of a given crystallographic orientation, without any deviation of the growth axis. High temperature gradients in the melt results in the stability of a smooth crystallization front. Growth of the crystal from the melt occurs without contact with the walls of the crucible that allows setting the geometric shape, by varying the melt temperature & pulling rate. 5. This method produces crystals with low inner stress.	1. Slow cycle, which needs 6-12 months for growing crystals. Melted with a flux and cooled very slowly, mimicking the nature's processes. Worth waiting for expensive gemstones. LifeGem uses rough stones made from this process for Emerald. 2. Expensive method, as Platinum accessories & crucibles are used. 3. Un-dissolved flux results in small inclusions like natural gemstones. 4. The product is very stable with a life-time guarantee for the colour.	1. Cheaper to produce & high rates of production; takes only a few hours to create the gemstones by melting the similar composition of minerals and colour elements with flame and dropping them into a 'boule'. 2. Least expensive & most commonly used; impossible to get crystals of high quality by this method. Spread of colour & impurities are unequal in the crystals, which have curved growth & fracture porosity. 3. Difficult to control the process & to achieve the same quality. Gas bubble inclusions & cracking due to T-gradients make the gems inferior. 4. The process is subject to an open-air environment (as against a vacuum environment in other processes) and hence the crystals contain air - bubbles that trap light, diminishing the dispersion and 'dulling' the stones.	1. The process is economical and takes 3 - 4 weeks to grow. 2. Cheaper containers are used, made out of steel. Crystals contain solvent impurities. For example in Emerald, the grown crystals have slightly yellowish green and fully bluish green colour, which cannot be classified as the Emerald colour. (Emerald is dark green or slightly bluish green beryl. Yellow-green beryl is called heliodor and light green beryl is just called green beryl). 3. The minerals are subject to intense heat and pressure, in a sort of pressure cooker. Hence, the crystals contain water that affects their color and quality.

Lab-created gemstones for jewellery –

LifeGem has partnered with the best lab-created gemstone manufacturer in Europe. All our gems except Emerald are grown using the Czochralski method, which allows to grow crystals of high optical quality. They do not contain any defects (bubbles, cracks, inclusions). Emerald is grown by the Flux method, which is a perfect analog of natural Colombian Emerald.

The following lab-grown gems are available with us in various shapes and sizes, from 6 mm to 15 mm in size (from 1 carat to 16 carats in weight) -

1. Alexandrite – LifeGem Alexandrite ($\text{BeAl}_2\text{O}_4:\text{Cr}^{3+}$) is a first-class precious stone, one of the hardest and long living jewels (only diamond, sapphire and ruby come before).

The most marvelous property of this gem is its ability to change color in accordance with the source of light. Alexandrite becomes green like Emerald in the day light; artificial lightening makes this magic stone purple-red like Ruby. **LifeGem** has the perfect technology for obtaining a natural analog of Alexandrite.

2. Ruby – LifeGem Ruby crystals ($\text{Al}_2\text{O}_3:\text{Cr}^{3+}$) are grown to obtain high quality samples and to create their color purposely - from light-red to pigeon's blood color. Laboratory studies have verified these crystals as the complete analogs of naturally occurring ruby.

3. Emerald ($\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}:\text{Cr}$) – Grown by the most expensive Flux method, **LifeGem's** emerald is a perfect analog of natural Colombian emerald.

4. Violet-blue Forsterite (Tanzanion) – LifeGem's CO^{2+} doped $\text{Mg}_2\text{SiO}_4:\text{CO}^{2+}$ Tanzanion crystal is a full analog of violet-blue (tanzanite colour) natural Forsterite and accordingly a simulant of natural Tanzanite. Natural Tanzanite cannot be lab-created in high melting temperatures, as it contains 2% water. Natural Tanzanite has limited reserves, but the beauty of Tanzanion crystal is unlimited.

5. Light green Forsterite (Peridot) - Forsterite (Mg_2SiO_4) in light green is also called 'Peridot', which is prized as a jewellery stone since ancient times.

6. Sky-blue Chrysoberyl (BeAl_2O_4) – Grown by the Czochralski method, **LifeGem's** sky-blue Chrysoberyl is a full analog of natural Chrysoberyl.

7. Aquamarine Chrysoberyl (BeAl_2O_4) - Chrysoberyl in aquamarine colour is a fine gemstone, with excellent hardness and brilliance.

8. Red Spinel ($\text{MgAl}_2\text{O}_4:\text{Cr}$) – The deep-red variety of Spinel is the most prized mineral because of its luster, durability and hardness. It is created in the laboratory to match all the properties of natural red Spinel.

9. Blue Spinel (MgAl_2O_4) – Blue Spinel is one of the rarest colours of Spinel. It has a cubic structure like diamond and is highly desired.

10. Sky-blue Spinel (MgAl_2O_4) – Sky-blue Spinel display more brilliance and fire, with a single refraction like diamond.

Properties of LifeGem created gemstones, using Czochralski crystal pulling method & Flux method

	LifeGem created gemstones	Chemical composition	Axial characteristics	Refraction indexes	Moh's hardness	Density (g/cm^3)	Melting point ($^{\circ}\text{C}$)
1.	Alexandrite	$\text{BeAl}_2\text{O}_4:\text{Cr}^{3+}$	biaxial	$N_g = 1.753$ $N_m = 1.747$ $N_p = 1.744$	8.5	3.79	1,870
2.	Ruby	$\text{Al}_2\text{O}_3:\text{Cr}^{3+}$	uniaxial	$N_m = 1.767$ $N_p = 1.759$	9	3.98	2,050
3.	Emerald	$\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}:\text{Cr}$	biaxial	1.558 -1.562	8	2.65	At 1,300 $^{\circ}$ C, phase - transition takes place.
4.	Violet-blue Forsterite (Tanzanion)	$\text{Mg}_2\text{SiO}_4:\text{CO}^{2+}$	biaxial	$N_g = 1.670$ $N_m = 1.651$ $N_p = 1.635$	7	3.22	1,895
5.	Light green Forsterite (Peridot)	Mg_2SiO_4	biaxial	$N_g = 1.670$ $N_m = 1.651$ $N_p = 1.635$	7	3.22	1,895
6.	Sky-blue Chrysoberyl	BeAl_2O_4	biaxial	$N_g = 1.753$ $N_m = 1.747$ $N_p = 1.744$	8.5	3.79	1,870
7.	Aquamarine Chrysoberyl	BeAl_2O_4	biaxial	$N_g = 1.753$ $N_m = 1.747$ $N_p = 1.744$	8.5	3.79	1,870
8.	Red Spinel	$\text{MgAl}_2\text{O}_4:\text{Cr}$	isotropic	1.718-1.75	8	3.6	2,135
9.	Blue Spinel	MgAl_2O_4	isotropic	1.718-1.75	8	3.6	2,135
10.	Sky-blue Spinel	MgAl_2O_4	isotropic	1.718-1.75	8	3.6	2,135

Lab-grown gemstones vs. mined gemstones -

For the following 6 reasons, lab-created gemstones are excellent alternatives to the more expensive and hard-to-find natural gemstones in jewellery –

1. AN IDENTICAL GEMSTONE -

Because of the identical mineral make-up of a lab-created gemstone, only a trained professional can tell the difference between a natural stone and a lab-grown one. Scientists are able to get the chemical qualities and appearances of nearly any gemstone in their labs, including Emeralds, Alexandrites, Spinel and Rubies. These stones are visibly identical to their natural version in color, hardness, composition and luster.

Natural gemstones develop inclusions from the crystallization process that involves gases and other minerals mixing in the molten stage of the stone creation, which adversely affects the value of the gem.

Because lab-created gemstones do not have gases added in the same way that nature does, inclusions do not have a chance to form in the stones. This makes the quality of the gem higher.

2. A VARIETY OF AVAILABLE SIZES AND COLOURS -

Gemstones that vary from their traditional colors do occur in nature, but generally these variations are much rarer and much more expensive to use in jewellery. Lab-created gemstones provide an opportunity to procure these stones in a specified size and color. This allows jewellery designers to customize their jewellery with specific stone colors.

3. AN UNLIMITED SUPPLY -

Mined gemstones are in a limited supply. Because the earth's process for creating gemstones involves lots of heat and pressure deep below its surface, gems are not being formed at a rapid rate. As mines continue to retrieve and sell gems quickly, the natural gemstone supply is being depleted around the world. Lab-created stones, however, are available in an unlimited supply because they can be created in a laboratory rather than inside the earth.

4. ENVIRONMENTAL AWARENESS -

Gemstone mining involves a massive operation that covers a large area of what was previously natural land. These mechanical systems for retrieving gemstones destroy the natural habitats of many plants, animals and birds. In fact, mining operation can destroy the entire ecosystems. Laboratories that create gemstones, on the other hand, work in a controlled area and use a moderate amount of resources.

5. A CONFLICT-FREE GUARANTEE -

Many gemstones are mined in war-torn regions. A great number of these regions are in Africa, where the profit earned from the sale of these gemstones goes to fund civil wars and renegade armed forces. Even in regions that do not have current conflicts or rebel forces, many mining operations have sub-standard working conditions that employ and over-work child laborers. Some of these operations also abuse human rights by providing unsafe and unsanitary work environments for the miners working on the gemstones. Gems created in controlled facilities are produced by trained scientists and engineers. This ensures that children cannot work in these facilities, and these trained professionals require good working conditions to continue their jobs.

6. A MORE AFFORDABLE PRICE -

Purchasers of natural stones must pay for the process of locating the gemstones, mining the gems from deep in the earth, and carefully cutting the stones to the perfect size and shape. This process becomes very expensive, even for a small natural stone. On the other hand, customers of lab-created stones only need to pay for the laboratory process that created the stone. Rather than paying for the rarity of the stone and for the massive mining operation that retrieved the stone, buyers can simply select a stone perfect for their jewellery from the gems that have been created.

Whether lab-grown gemstones can be used for astrological purposes?

It is argued that natural stones are astrologically effective because they have been formed over thousands of years & they have the energy which lab-grown stones do not.

On the other hand, following arguments are in favour of lab-grown gemstones –

- 1) The process of lab-growing of gemstones is free of impurities and hence more effective.
- 2) Natural gemstones form within 2-3 months in nature and not thousands of years. Some of the lab-grown processes take the same time.
- 3) Almost all the natural gemstones used for astrological purposes are 'treated' natural stones, as the un-treated stones are extremely rare and ultra-expensive. Such natural stones, heat-treated to give colour saturation, destroy any astrological effect.
- 4) The astrological potency of a stone depends on colour refraction, brilliance, clarity & the weight of at least 4 carats. Natural gemstones with impurities & colour-treatments cannot achieve these objectives. Lab-grown gemstones, where the growing process is isolated completely from the external forces, are much more effective and powerful.

Lab-created gems are not synthetics - they are real with the same chemical composition, physical appearance & optical qualities. The only difference is they are 'grown' by men, while natural gems are 'found' by men. A trained gemologist, after thorough examination using the advanced gemological equipments, can only tell the difference.

Thus, Lab-created gemstones in jewellery are an excellent alternative to naturally occurring gemstones. These stones are identical in physical appearance and chemical composition to their natural counterparts, but lab-created stones are more environmentally friendly, socially conscious, and available at a fraction of the price.

LifeGem Guarantees –

LifeGem lab-grown gemstones come with a life time guarantee for colour, clarity and shining. They do not fade away despite the daily use and exposure to house-hold acids & alkalies.

Note - The breaking strength & scratch-resistance of these gems depend on their Moh's hardness. Forsterite with a hardness of 7 needs proper care, as it can be broken or scratched. Alexandrite & Chrysoberyl are substantially hard (moh's 8.5) and resistant to environmental conditions. Avoid external mechanical impact on all the gemstones.