

# Ruby

## Ruby



Ruby crystal before faceting, length  
0.8 inches (2 cm)

## General

Category

Mineral variety

Chemical formula

aluminium oxide with chromium,  
 $Al_2O_3::Cr$

## Identification

Color

Red, may be brownish or purplish

Crystal habit

Varies with locality. Terminated tabular  
hexagonal prisms.

Crystal system

Trigonal

Cleavage

No true cleavage

Fracture

Uneven or conchoidal

Mohs Scale hardness

9.0

Luster

Vitreous

Refractive index

~1.762-1.770

Pleochroism

Orangey Red, Purplish Red

Ultraviolet fluorescence

red under longwave

Streak

White

Specific gravity

4.0

Melting point

2050°C

Fusibility

perfectly

Solubility

None

Diaphaneity

transparent

**Ruby** is a pink to blood red gemstone, a variety of the mineral corundum (aluminium oxide). The common red color is caused mainly by the element chromium. Its name comes from *ruber*, Latin for red. Other varieties of gem-quality corundum are called sapphires. It is considered one of the four precious stones, together with the sapphire, the emerald and the diamond. Improvements used include color alteration, improving transparency by dissolving rutile inclusions, healing of fractures (cracks) or even completely filling them.

Prices of rubies are primarily determined by color (the brightest and best "red" called Pigeon Blood Red, command a huge premium over other rubies of similar quality). After color follows clarity: similar to diamonds, a clear stone will command a premium, but a ruby without any needle-like rutile inclusions will indicate the stone has been treated one way or another. Cut and carat (size) also determine the price.

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### 1. Physical properties

Rubies have a hardness of 9.0 on the Mohs scale of mineral hardness. Among the natural gems only diamond is harder, with a Mohs 10.0 by definition.

All natural rubies have imperfections in them, including color impurities and inclusions of rutile needles known as "silk". Gemologists use these needle inclusions found in natural rubies to distinguish them from synthetics, simulants, or substitutes. Usually the rough stone is heated before cutting. Almost all rubies today are treated in some form, with heat treatment being the most common practice. However, rubies that are completely untreated are still of excellent quality and command a large premium.

Some rubies show a 3-point or 6-point asterism or *star*. These rubies are cut into cabochons to display the effect properly. Asterisms are best visible with a single-light source, and move across the stone as the light moves or the stone is rotated. Such effects occur when light is reflected off the *silk* (the structurally oriented rutile needle inclusions) in a certain way. This is one example where inclusions increase the value of a gemstone. Rubies can furthermore show color changes — though this occurs very rarely — and chatoyancy.

## 2. Treatments and enhancements

Improving the quality of gemstones by treating them is common yet time-consuming practice. Some treatments are used in almost all cases and are therefore considered "acceptable" practices. The most common treatment is using heat. Most if not all rubies at the lower end of the market are heat treated. Heat treatment is performed on the rough stones to improve color, remove *purple tingle*, blue patches and silk. These heat treatments typically occur around temperatures of 1800°C (3300°F). Some rubies undergo a process of low tube heat, when the stone is heated over charcoal of a temperature of about 1300°C (2400°F) for 20 to 30 minutes. The silk is only partially broken as the color is improved.

A less acceptable treatment, and one which has gained notoriety in recent years is "Lead Glass Filling" of Rubies. By filling the fractures inside the ruby with lead glass the transparency of the stone is dramatically improved making previously unsuited rubies now fit for applications in jewelry. The process is typically done in 4 steps:

1. The rough stones are pre-polished to eradicate all surface impurities that may affect the process
2. The rough is cleaned with hydrogen fluoride
3. The first heating process whereby no fillers are added. The heating process eradicates impurities inside the fractures. Although this can be done at temperatures up to 1400°C (2500°F) it most likely occurs at a temperature of around 900°C (1600°F) since the rutile silk is still intact
4. The second heating process in an electrical oven with different chemical additives. Different solutions and mixes have shown to be successful, however mostly lead-containing glass-powder is used at present. The ruby is dipped into oil, then covered with powder, embedded on a tile and placed in the oven where it is heated at around 900°C (1600°F) for one hour in an oxidizing atmosphere. The orange colored powder transforms upon heating into a transparent to yellow-colored paste, which fills all fractures. After cooling the color of the paste is fully transparent, that dramatically improves the overall transparency of the ruby.

In case a color needs to be added, the glass powder can be "enhanced" with copper or other metal oxides as well as elements such as sodium, calcium, potassium etc.

The second heating process can be repeated three to four times consecutively, even applying different mixtures.

### 3. Synthetic and imitation rubies

In 1837 Gaudin made the first synthetic rubies by fusing aluminium at a high temperature with a little chromium as a pigment. In 1847 Edelman made white sapphire by fusing alumina in boric acid. In 1877 Frenic and Freil made crystal corundum from which small stones could be cut. Frimy and Auguste Verneuil manufactured artificial ruby by fusing  $\text{BaF}_2$  and  $\text{Al}_2\text{O}_3$  with a little Chromium at red heat. In 1903 Verneuil announced he could produce synthetic rubies on a commercial scale using this flame fusion process.

Other processes in which synthetic rubies can be produced are through the Pulling process, flux process, and the hydrothermal process. Most synthetic rubies originate from flame fusion, due to the low costs involved. Synthetic rubies may have no imperfections visible to the naked eye but magnification may reveal curved striae and gas bubbles. The fewer the number and the less obvious the imperfections, the more valuable the ruby is; unless there are no imperfections (i.e., a "perfect" ruby), in which case it will be suspected of being artificial. Dopants are added to some manufactured rubies so they can be identified as synthetic, but most need gemmological testing to determine their origin.

Imitation rubies have also been present in the gemstone market for some time. Red spinel, red garnet and even glass have been falsely named as rubies. Imitations go back to Roman times and already in the 17th century techniques were developed to color foil red -- by burning scarlet wool in the bottom part of the furnace -- which was then placed under the imitation stone. Trade terms such as balas ruby for red spinel and rubellite for red tourmaline can mislead unsuspecting buyers. Such terms are therefore discouraged from being used by many gemological associations such as the Gemological Institute of America (GIA).

### 4. Records

Although pieces of red corundum can be found weighing many kilograms, they are generally not of sufficient quality to be valuable as gemstones. For this reason, auction prices are the best indicator of a stone's true value, and prices do not necessarily correlate with size. As of 2006, the record price paid at auction for a single stone was \$5,860,000 for an unnamed 38.12 carat cabochon-cut ruby.

## 5. Historical and cultural references

- According to Rebbenu Bachya, and the New International Version, the word *odem* means "ruby" in the verse Exodus 28:17 (referring to a stone on the Hoshen), and was the stone representing the tribe of Reuben. Modern Hebrew has taken this meaning. However, *odem* actually means *earth*, and is cognate with *Adam*; in the Middle East, the earth it refers to is certainly reddish, but the Septuagint translates the term as *Sard* (which also means red), which is also the name of a common, somewhat opaque, gem. Scholars think the stone intended is probably a *Sard*, as does the King James Version, scholars think that if not a *Sard* it may possibly be the related gem *carnelian*; it is thought possible that *Sard* and *Odem* here just mean the colour of the stone, and red *Jasper* would therefore also be a possibility.
- Ruby is the most commonly named precious stone in English translations of the Bible; an example being Proverbs 31: "*A virtuous wife is worth more than rubies*". The underlying masoretic text doesn't necessarily refer to rubies, however. Not only are there issues such as that mentioned with *odem*, but in the case of Proverbs 31, the masoretic text merely states *jewels*, and the Septuagint makes Proverbs 31 refer to *precious stones (estin lithon)*; some English versions of the bible believe that *pearls* is a better translation here.
- An early recorded note of the transport and trading of rubies arises in the literature on the North Silk Road of China, where in about 100 BC rubies were carried along this ancient trackway moving westward from China.
- The famous lighted "Red Stars" mounted above Kremlin spires, thought to be giant rubies mined in Siberia, are colored glass.
- Ruby is the birthstone associated with July and of the zodiac sign Leo and Cancer.
- Ruby is associated with the Sun in Vedic astrology.
- Ruby is associated with a 40th wedding anniversary.
- Rubies have always been held in high esteem in Asian countries. They were used to ornament armor, scabbards, and harnesses of noblemen in India and China. Rubies were laid beneath the foundation of buildings to secure good fortune to the structure.

## 6. Valley of Rubies

Of the world's rubies, 90% currently derive from Myanmar (Burma) whose red stones are prized for their purity and hue. Thailand buys the majority of Myanmar's gems. Myanmar's "Valley of Rubies", the mountainous Mogok area, 200 km (125 miles) north of Mandalay, is noted for its rare pigeon's blood rubies and blue sapphires. But working conditions in the mines are horrendous. Debbie Stothard of the Alternative ASEAN Network on Burma stated that mining operators used drugs on employees to improve productivity, with needles shared, raising the risk of HIV infection: "*These rubies are red with the blood of young people.*" Brian Leber (41-year-old jeweler who founded The Jewellers' Burma Relief Project) stated that: "*For the time being, Burmese gems should not be something to be proud of. They should be an object of revulsion. It's the only country where one obtains really top quality rubies, but I stopped dealing in them. I don't want to be part of a nation's misery. If someone asks for a ruby now I show them a nice pink sapphire.*" In 2007, following the crackdown on pro-democracy protests in Myanmar, human rights organizations, gem dealers, and US First Lady Laura Bush called for a boycott of a Myanmar gem auction held thrice yearly, arguing that the sale of the stones profits the dictatorial regime in that country.

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