CHAPTER-1 INTRODUCTION

Natural gemstones are found in various parts of the world, but the availability of the best quality gemstones do not always meet the current demand around the world. Very less amount of good quality gemstones are produced form the different mines of the world, while low quality gemstones are easily available in the gem market. Hence, researchers develop different methods to treat and enhance the low quality gemstones to better quality.

In the last few years, the technique of gemstone enhancement has received a great amount of attention in the world. As a result, good quality and quantity of gemstones are available in the market at a lower prize. The colour and clarity of gemstones have become more sharp, which is not observed in the natural gemstones but is possible in both treated and synthetic gemstones. Gemstones are the most valuable material a man would like to possess, because of its intrinsic properties of beauty and durability, apart from other attributes such as rarity and portability, etc. They are not only used as personal adornment but also for the belief that they bestow supernatural powers on the wearer.

Among the available gemstones, large amount of them possess one or more of the appealing qualities such as colour, luster, transparency, brilliance, fire, etc.

Since, gemstones are mainly used for personal adornment and for the purpose of decoration, it is required that it should be resistant to scratching and abrasion, as this would dull the gemstone's luster and reduce its beauty. Secondly, the quality of gemstones is also affected by the factor of durability, which depends on its hardness and toughness.

The interest of mankind in gemstones is ancient and extends back to the pre-historical times. Archaeological discoveries show that our remove ancestors collected and treasured gemstones and when used them as ornaments.

The term 'enhancement' is defined as any process other then cutting and polishing, that improves the appearance i.e. colour or clarity phenomena, durability or availability of a gemstone. Some of the treatments which are not obvious or known by the purchaser are heating, irradiation, bleaching, dyeing, diffusion and filling fractures with compounds.

There are various reasons for which gemstones are enhance, few of them are:

Beauty: The treatment of a gemstone can change and significantly improve its appearance. The enhancement would produce a gemstone with a better a stable colour and clarity then the original material.

Fashion: Enhanced or treated stones are available in beautiful colours which are rarely found in natural ones, this fulfils the desire of buyers who wish to buy something new and better.

Value: The availability of best natural gemstones is less and are much expensive as well, whereas the lower quality gemstones are available easily at a low prize, when such a material is treated or enhanced, the final product will always sale at a comparable higher value.

Demand: The demand for beautiful gemstones has always been high but the supply or availability is comparatively less, henceforth, this high demand is fulfilled by enhanced or treated gemstones.

The gemstones treatment is divided into two categories:

1). Methods which change the colour,

2). Methods which change the clarity.

Several techniques of gemstone enhancement are developed during gemstone synthesis and crystal growth by using the knowledge of lattice structure, chemical composition, melting point, presence of transition metal iron, geological occurrence and knowledge of crystallisation, temperature, environment and optical effect in different gemstone (gem crystal).

The two main categories considered for gemstone quality improvement are:

1). Enhanced Stones: When gemstone quality is improved by heating (where the change is permanent) or impregnation by a colourless oil or resin.

2). Treated Stones: When gemstone quality is improved by irradiation, diffusion, coloured impregnation (dye), coating, fracture filling with glass and lasers.

There are several physical as well as chemical methods used for defecting both treated and untreated gemstones including Beryl, Chalcedony, Corundum, Diamond, Pearl, Quatz, Topaz etc.

My aim was to find out certain methods for detection of treated and untreated gemstones in different size, colour and clarity.

In cases of loose bigger size gemstones (greater than one cart or more), it is possible to identify by naked eye or by 10X or 20X hand lens/lope, whereas for the smaller size gemstones, it is possible to identify under a microscope (on the basis of inclusion), by chemical reactions (acid), using hot point or by scratching the gemstone by a pointed material such as a needle, etc. which I would emphasize upon and discuss in detail in my thesis.

Identification of irradiated gemstone is possible by using a simple microscope or a hand lens. Secondly, by using Geiger Muller Counter, the radioactivity of a gemstone can be traced and the structural disturbances because of irradiation can be traced with the help of spectroscopy (Infrared and Raman Spectrum).

When a cyclotron related diamond is observed under a microscope, the crown portion shows a dark ring within the girdle, whereas those irradiated from pavilion show many light and dark shadow lines around culet. But in cases, where in the irradiation is at side, it shows colour zone near the girdle.

In Diffusion treatment, the material is easily identified in methylene iodide or glycenine, in which the gemstone colour concentration is noticed around different faces of gemstone. Heat treated gemstone is identified under a microscope or lens, or by repolishing the outer surface of gemstone or by observing under ultra violet light or ultra red spectroscopy.

Diamond is rightfully regarded as one of the most expensive minerals. Even tiny diamond silvers cost hundreds of times more than their weight in platinum or gold, whereas large diamonds are practically priceless compared to other precious stones. By cutting and polishing, a rough diamond is transformed by diamond cutters into a gem diamond notable for its amazing property of converting a beam of light into a lively rainbow. At the slightest movement, such a stone sparkles and is iridescent with a play of gay colours in lovely hues.

As we know from school physics, a beam of white light is made up of beams of various colours. They comprise the spectrum of which the outermost are the red and violet beams. In passing through various transparent substances, a light beam is differently refracted and, moreover, each colour has its own definite kind of refraction. The substance transmitting the beams is specified by their indices of refraction and by the difference of the indices of refraction for the red and violet beams. This difference is known as the dispersion of the given transparent substance. The fire and sparkle of a diamond crystal is due to its high indices of refraction and high dispersion. A beam of white light, after refraction in a diamond, produces a more widely divergent bunch of spectral rays and, therefore, a more prominent interplay of rainbow like colours.

With respect to clarity diamond is divided into several categories. In the clearest crystal no imperfections are visible even under ten-power magnification; such diamonds are said to be flawless. The least transparent crystals, with defects visible to the unaided eye, are said to be heavily flawed. But even the most perfect diamond crystal (called a diamond of the first water) has various inclusions and impurities. Their presence determines the absorption of beams from various parts of the spectrum by the stone. This, in its turn, also influences the colour effects of the diamond.

Generally, the colourless diamond that brings the highest price in the market. But, the diamond crystals of bright pure tones of red, green, blue or orange colours are found in nature. They are called “fancy colour” diamonds and are valued even higher than the colourless ones. The value of a diamond crystal depends, not only on its clarity and colour, but on its cut, the quality of polishing and the shape of the finished gemstone. The most frequently used are the rose, marquise, brilliant and pear cuts. The brilliant cut is the most popular one because the stone acquires maximum lustre, and is full of fie and sparkle.

The chemical composition of the diamond consists of carbon, which is very abundant in nature. Both graphite and coal consist of atoms of carbon; molecules of graphite and coal have exactly the same number of atoms as a molecule of white diamond. Such diamond is purest carbon and the colour of the crystal is imparted by impurities. Diamond consists of pure carbon. But, carbon atoms can be arranged in another crystal lattice having a different type of atomic bond and forming a substance with properties drastically differing from the diamond. As we know that the graphite has a complex lamellar structure with the distance 3.39 A^o between the layers.

Whereas the diamond acquired its unique properties as a result of the unusual conditions under which it was formed millions of years ago. Intense hear and huge pressures in the depths of the earth forced the carbon atoms to align themselves in a regular cubic lattice that imparted unsurpassed hardness to this mineral.

Diamond is valuable, not only for its extraordinary optical properties, which are found, to some extent, in other minerals, for example, zircon. The diamond crystal attracts the attention of scientists because of its high mechanical durability. The mechanical durability of a crystal is determined by its hardness, i.e. its resistance to indentation or to scratching by another substance.

Diamond has extremely high chemical stability. It is not dissolved in even boiling sulphuric, nitric or hydrofluoric acid, or in their mixtures which have a destructive effect on other minerals. It cannot be damaged by boiling perchloric acid, which readily dissolves graphite. But, diamond is slowly oxidized in an alkaline melt, and is more stable than graphite when it is oxidized by oxygen. Neither molecules nor atoms of hydrogen have any effect on diamond, whereas graphite readily turns into a gas in interaction with hydrogen atoms.

Natural diamonds may be of various quality which are suitable for jewellery are usually cut to make gems. Lower quality natural diamonds are considered to be industrial stones and are extensively used in the whole field of engineering practice. Approximately two-thirds of the diamonds retrieved by the mining activities are used as industrial stones.

Diamond has been used since ancient times for working hard materials. Diamond-tipped tools, in particular, knives with diamond cutting edges, were widely used in ancient India. In China such tools were used for carving jade. Some literatures stated that Egyptians used the diamond tools six thousand years ago in building the pyramids. From time immemorial mankind has made use of the diamond for grinding, polishing, drilling, boring and cutting various hard materials that simply could not be worked by other means.

Detailed observation of internal features is very important to identify treated gemstone under microscope or hand lance. As many crystal inclusions have lower melting point than the host Gem. They may melt or discolour by heating process. Silk inclusion, which is almost always seen in rubies and sapphires, is actually needle-like crystal of Rutile, which breaks into dots when heated at high temperature and eventually disappears The temperature they melt varies according to the atmosphere and other conditions of heating process. The existence of silk inclusion that shows no sign of alteration has been long believed as an evidence of unheated status, however, recently low temperature heating process (under 1000ºC?) attracted controversy and the identification became more complicated.