THE GEM & JEWELLERY EXPORT PROMOTION COUNCIL
Sponsored by the Ministry of Commerce & Industries, Govt. of India

GEM TESTING LABORATORY

Lab Information Circular

Volume 62, September 2011

Coated Gemstones – Changing Trends!

Coating on gemstones is known for many decades, which is primarily done to improve their appearance (colour and lustre) and / or durability. Coating refers to depositing a layer(s) of coloured or colourless substance(s) on the surface of a gemstone. For centuries, gemstones are being coated with coloured inks or paints to improve the colour but with advancement in technology, various types of advanced coatings have been developed and are routinely being applied on gemstones to improve their appearance and durability and hence the value. These new versions of coating are much more advanced and provide a wide range of colours with better durability. The pursuit for new gem materials and fancy colours at affordable prices has made these coated gemstones widely accepted by the jewellers, jewellery designers as well as consumers. Hence, these coated gemstones have become quite popular in the recent past. The best example is that of iridescent coating performed on topaz or quartz, being marketed as 'Mystic'; similar coating is also performed on 'drusy quartz'. In addition, coated diamonds in fancy colours have also gained a lot of popularity; this is mainly produced in pink, orange and blue colours.

Today coating is done using several types of compounds which may include metals, oxides, fluorides, etc. Various metals such as iron, cobalt, gold, silver, titanium, etc gives rise to a range of colours to the coating layer and hence the gemstones. Coating however, is not always done to produce fancy material but also to deceive jewellers and consumers.

Advanced methods for coating employed include vapour deposition of the chemical compounds using sputtering technique. This uses ion beam which targets the metal where atoms from metal vaporizes and deposits on the gem material. In some cases, sputtering is followed by heat which improves the overall adhesion of coating layer with the stone; various gases are also used to produce different compounds. Traditional method on the other hand, involves the application of colouring agent along with an adhesive on the surface of gemstones.

Coating can be done on any gem material; however some of the most common ones include topaz, quartz (rock crystal and drusy) and glass. Following are few encounters of coated materials at the Gem Testing Laboratory, Jaipur.

Topaz

Topaz is known to be coated for many decades now. The term 'aqua aura' was used for topaz coated with a layer of gold which gives a metallic appearance to the stone with blue colours being visible at certain angles. Later, since the beginning of this century, iridescent coatings were started to be applied where the appearance of stones change as per the angle of viewing. Such coated topaz was widely accepted all over and millions of carats were then treated every year.

Figure 1: Few colours of coated topaz

The iridescent effect is produced by coating alternate layers of materials with high and low refractive index such as TiO_2 and SiO_2. Therefore, due to the differences in refractive index of two layers, light gets interfere from the top layer and layers within, creating spectral colours. During the same periods, a range of fancy colours of topaz were created by using coating; the most common colours were blue and pink. In addition to this, experiments were performed to diffuse chemical compounds into the lattice of topaz so that the treatment becomes relatively more durable in terms of routine wear and tear. This was however, later marketed as 'TCF', which stands for Thermal Colour Fusion. Technically, this process is not exactly a diffusion process as is the case in corundum, but just a fusion of coloured layer with the surface of topaz. As a result of application heat, adhesion between colouring layer and the stone is much more durable. A wider range of colours are being produced in this manner, in various shades of blue, pink, green, etc.

Fashion jewellery uses a range of coloured topazes which are coated in a crude way, where the stones are covered simply with ink or paints. The colour is very much unstable and comes off in sweaty fingers or with an acetone-dipped cotton swab.

Figure 2: Iridescent coating on 'drusy quartz' and rock crystal

Quartz

Mainly two varieties of quartz are coated; rock crystal and drusy. Both these varieties are used to produce iridescent and metallic coating (Mystic). Drusy quartz is specifically used for metallic coatings in gold, silver, and copper colours. With the development of metallic and iridescent coatings on drusy quartz, the usage of this gem variety has increased tremendously in the last few years. Prior to this, this variety was hardly used as a gem. This coating has provided a wider range and type of materials to be used in fashion jewellery. As far as rock crystal is concerned, both natural as well as synthetic counterparts are used for coating. In the last six months or so, we have seen almost 50% of the coated rock crystals as synthetic.

Colourless quartz (rock crystal) is also coated with coloured substances like paints, plastics or polymers to imitate well known gem materials like emerald.

Figure 3: 'Plastic' coated quartz, imitating emerald

Glass

Coated glasses are widely known as 'Chaton' or 'Rhinestone' is used in fashion and costume jewellery. In this case, coating is primarily done on pavilion to increase the colour as well as the brilliance to otherwise a dull material.

Figure 4: Chaton

Tanzanite

In May 2008, coated tanzanites were first reported by the American Gem Trade Association - Gem Testing Center (AGTA-GTC) and American Gemological Laboratories (AGL), and since then we have received coated tanzanites only occasionally. Coating of tanzanite is usually applied on smaller sized stones. Smaller sizes are generally paler and do not display their maximum colour, therefore, in order to enhance colour of these smaller sized tanzanites, coating was developed. The blue colour is created by the application of cobalt oxide as the colouring agent and is applied only on the pavilion facets. If not observed carefully, identification is not that easy / simple as in other cases. In larger sized stones, identification is even more difficult. Coating as in other cases, is identified by following the simple features such as iridescence and/or chipping of coating material from the facets or their edges are also seen here. However, if stones are kept in separate packets, these features might not be observed, making the identification lot more challenging. In such cases, elemental analysis becomes the conclusive test as is done at the Gem Testing Laboratory, Jaipur. Although as seen in the last three years or so, the penetration of these coated tanzanites is not much, but still one has to be alert and careful regarding their presence.

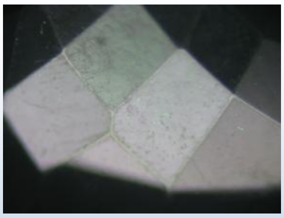
Figure 5: A coated tanzanite

Black Spinel

Since the year 2007, we have seen many specimens of black spinels which gave the appearance of black diamonds, mainly due to its metallic to adamantine lustre. The original material was black spinel which has a vitreous lustre but when coated give much brighter lustre thereby imitating black diamonds. These were coated with tin (Sn) and titanium (Ti) to produce metallic and metallic blue lustres respectively. Other than the visual appearance, no observational features were present to prove them treated. Elemental analysis revealed the presence of Sn and Ti; re-polishing removes the coated layer, revealing the vitreous lustre.

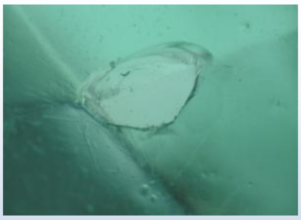
Figure 6: A coated black spinel

Box A: Features seen in coated gemstones

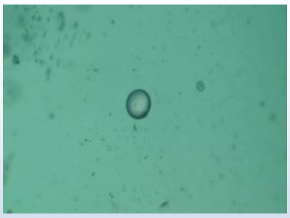


a. Subtle iridescence and chippings in a coated tanzanite

b. Colour concentration of coated / colouring substance in surface cavities in a coated topaz. Similar effects may be seen in any gem material



c. In some cases, the coloured layer chips off, revealing the true colour of the material, as in this coated quartz, imitating emerald



d. Substances coated with plastics, paints or polymers often display trapped gas bubbles confined to the surface layer

A greenish yellow zoisite

The mineral 'zoisite' is primarily known for its magnificent purplish-violetish blue coloured variety 'tanzanite'; however, due to the limited existence of this blue coloured variety in nature, most of the material available in the marketplace is derived by heating green to brown coloured zoisites. In addition to the common brown-green coloured varieties, some bright green to bluish green and yellowish green varieties coloured by chromium (see e.g, Barot N.R. & Boehm E.W., 1992), massive pink 'thulite', purple –pink and greenish yellow 'parti coloured' (Wentzell, 2000) and even red varieties (Koivula & Kammerling, 1991) have been documented in the literature.

Figure 7

We encountered one interesting and unusual greenish yellow specimen (figure 7) which turned out to be zoisite. A transparent pear shaped specimen weighed 8.33 carats and measured 14.87 x 11.89 x 7.80 mm was submitted for identification at the Gem Testing Laboratory, Jaipur, India. Initial observations, especially the colour shade indicated the stone being tourmaline, but turning the stone in different directions was sufficient to prove our presumption wrong; it displayed a striking strong pleochroism, often not associated with tourmalines. The presence of pleochroism was then confirmed with a dichroscope where three colours were obtained, namely, yellow, blue and purplish pink. This property became even more interesting when a polarising filter was used.

Figure 8

The specimen turned from yellow to blue and purplish pink on rotating the polarising filter 90° (figure 8). Both, blue and purplish pink colors were visible at the same time, where blue was seen towards the tip of the culet, while purplish pink colour towards the table of the stone. This was due to the differences in the line of transmission of the wavelengths in two areas, governed by the inclination of the pavilion facets.

Standard gemmological testing was performed to establish the identity of this specimen. Refractive index was measured at 1.695 – 1.703, with birefringence of 0.008 and hydrostatic specific gravity was calculated at 3.35. Under desk-model spectroscope, no absorption features were observed and was inert under both types of UV radiations. These properties (RI and SG) were consistent with those reported and known for zoisite. Under magnification, fine long tubes and cleavage planes were present, although did not proved to be of much significance in identification of the stone.

However, the specimen was identified on the basis of standard gemmological tests; it was further confirmed by the FTIR spectrum. The spectrum displayed strong peaks at around 4337 and 4015 cm^{-1}, a broad absorption band from 3800 to 2650 cm^{-1} and complete absorption of wavelengths from 2300 to 400 cm^{-1} with many small peaks at around 5423, 5176, 4822, 3876, 3850, 2480 and 2376 cm^{-1}. This spectral pattern matched exactly with those of tanzanites and few brown coloured zoisites present in our database. Quantitative EDXRF analysis revealed the presence of Al, Si, Ca and Sr as major elements while V and Fe were present only in traces. Therefore, on the basis of its RI, SG and FTIR spectrum, this greenish yellow specimen was conclusively identified as zoisite.

This was the first time when we encountered this very unusual colour shade of a zoisite. However, yellow / yellow-green varieties have been mentioned previously (see e.g. Barot & Boehm, 1992; Pearson, 2008; Webster, 1994) but no images have been found during the literature search, as imaged here in this report. Dissimilar color like this for a zoisite provides additional options for the jewellers and consumers other than the hues of familiar 'violet-blue' tanzanites.

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This write up was first appeared in The Australian Gemmologist, Vol.24, No.4, pp 90-91

A strongly thermoluminescent spodumene

Thermoluminescence is a property of some minerals whereby they display a bright glow when heated to a certain temperature. Minerals known to display this property include chlorophane (a variety of fluorite), apatite, calcite, lepidolite, and spodumene (see www.galleries.com/minerals/property/pleochro.htm#thermo). The Gem Testing Laboratory of Jaipur, India, recently examined a spodumene that displayed a striking example of thermoluminescence.

Figure 9

The pear-shaped green stone (figure 9) weighed 16.17 ct and measured 19.94 x 11.55 x 10.82 mm. Its colour was reminiscent of green beryl or emerald from Nigeria, but the bright lustre and liveliness ruled out the possibility of beryl. The following gemmological properties were recorded: RI—1.660–1.675; birefringence—0.15; hydrostatic SG—3.17; fluorescence—strong orange to long-wave UV radiation and strong pink to short-wave UV (figure..); and a weak absorption band visible in the blue region at around 440 nm in the desk-model spectroscope (no chromium lines were detected). These properties are consistent with those reported for spodumene (R. Webster, *Gems*, 5th ed., rev. by P. G. Read, Butterworth-Heinemann, Oxford, UK, 1994, pp. 186–189).

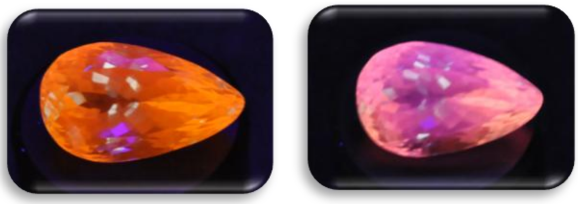

Figure 10

With magnification, a few liquid "fingerprints" were observed under the table and crown facets. Cleavage planes, a common feature in spodumene, were not evident.

Microscopic examination was conducted with the aid of a fiber-optic lamp. Curiously, when the examination was completed, the green spodumene appeared bright orange (figure 11). Within a few minutes, however, the original green colour returned. The orange glow was caused by the heat of the fiber-optic lamp exciting the spodumene's activator elements to produce thermoluminescence. The effect was similar to the stone's fluorescence reaction to long-wave UV radiation (again, see figure 10, left). The stone was reheated with the fiber-optic lamp and glowed orange again after three minutes of exposure, before returning to its original colour within two to three minutes after removal of the lamp. These steps were repeated several times with consistent results.

Figure 11

EDXRF analysis revealed the presence of Al, Si, and Fe. Mn, a common constituent in spodumene that is also responsible for its strong fluorescence (see M. Robbins, *Fluorescence: Gems and Minerals Under Ultraviolet Light*, Geoscience Press, Arizona, 1994, pp. 265–266), was not detected in this specimen. Therefore, the cause of the fluorescence and thermoluminescence is unknown.

This is the first time we have seen the heat of a fiber-optic lamp causing thermoluminescence in spodumene. Webster (1994) mentioned this effect occurring at temperatures around 200^{o}C. This spodumene's thermoluminescence at such a low temperature makes it quite an unusual specimen.

This write up was first appeared in Gems & Gemology, Vol. 46, No.4, pp 322 - 323

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