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VISUAL CHARACTERISTICS OF SYNTHETIC QUARTZ AS AN AID FOR IDENTIFICATION

Over the last 25 years, the gem industry has seen an increasing number of reports by associates and laboratories indicating a tremendous proliferation of synthetic quartz at all levels of the market. The stones reported were most often of the finest colours and with excellent clarity, often eye-clean. In recent years, there has been more material seen in colours without a natural counterpart.

For this project, information was gathered from previous research articles regarding visual features and methods of separating natural from synthetic quartz. During the project, conclusions reported in past articles were checked and verified on a collection of synthetic quartz samples. By combining the methods reported and the analyzed research results, 'a simple identification guide' for synthetic quartz has been created. Due to the fact that many identification methods used today remain inconclusive, the primary aim of this guide is to provide additional 'suspicious indicators' for gemmologists seeking to identify quartz stones of possible synthetic origin, by using the unaided eye, microscope, polariscope and infrared spectra.

BACKGROUND

For the past 35 years, researchers around the world have been working to develop a simple and accessible means of identifying synthetic quartz. Methods developed were either inconclusive or required high-tech equipment that was unavailable to most non-laboratory gemmologists. Due to the relatively low cost of natural quartz varieties, there was little demand in the trade for more reliable, low cost methods of distinguishing natural from synthetic.

During the 80's it was reported that up to 25% of the amethysts carried by far east dealers were synthetic (M. O'Donoghue, Artificial Gemstones). These were occasionally sold as natural and at attractive prices. The sizes of the synthetic stones were large to very large, reaching up to 57 carats (Thomas Hainschwang, Gemlab) and possessing excellent colours and with eye to loupe-clean clarity.

The need for a simple identification method becomes relevant. Since basic gemmological equipment (refractometer, dichroscope, specific gravity methods, etc.) cannot distinguish between the two origins and more sophisticated instruments (e.g. LA-ICP-MS) are not accessible to all gemmologists, the hunt for visual clues is the main technique used. Visual characteristics, which are usually clues and not diagnostic, can be detected using the unaided eye, microscope, polariscope and infrared spectra.

COLOUR

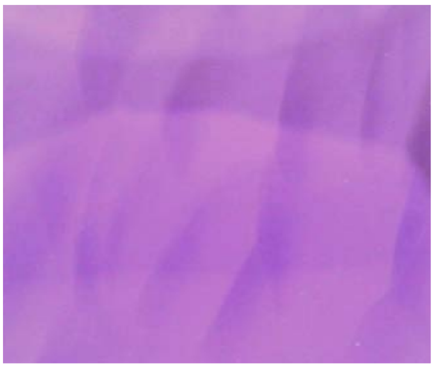
The synthetic quartzes reported in the trade come in all possible natural colours, as well as some not seen in nature. The more popular colours are the deep purple of the 'Siberian' amethysts and the deep orange of the 'Madeira' citrines. Also observed, the unusual deep green quartz (deeper and darker than the natural prasiolite, more of a tourmaline green), the greenish or yellowish brown smoky quartz (greener than the natural stone), the colourless rock crystal, and the clear transparent cobalt-coloured light blue (which does not exist in natural quartz and can be easily identified using spectroscope). Synthetic bi-colour stones are seen in ametrine colours (purple-yellow) as well as unnatural green-yellow or blue-yellow combinations.

Most of the synthetic stones tested were polished such that the table is oriented perpendicular to the c-axis. In multi-colour stones, the colour layers form perpendicular to the c-axis. Some bi-colour stones were polished with the table at 45° from the c-axis, so the colours seen through the table will 'merge' together, giving a metallic appearance.

A VARIETY OF SYNTHETIC QUARTZ CUT STONES. SOME POSSESSING COLOURS WHICH DO NOT EXIST IN NATURE, LIKE LIGHT BLUE, DARK GREEN, AND UNUSUAL BI-COLOURS.

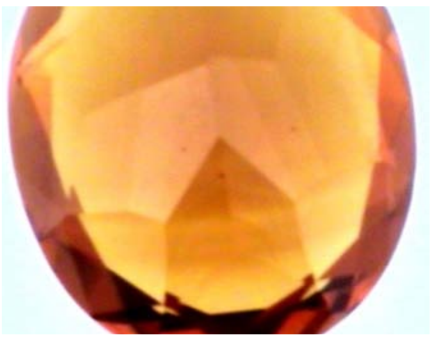
In some of the synthetic amethysts and citrines, the colour distribution was unusual, with a straight, streaky look (Thomas Hainschwang, Gemlab) or 'flame like' uneven colour pattern.

Some Russian synthetic amethysts have been reported showing a mauve to brown colour in particular orientations (M. O'Donoghue, Artificial Gemstones).



FLAME-LIKE COLOUR PATTERN IN SYNTHETIC AMETHYST.

BI-COLOURED SYNTHETIC QUARTZ POLISHED AT 45° FROM THE C-AXIS. THE COLOURLESS SEED CRYSTAL CAN BE EASILY SEEN.



UNEVEN COLOUR ABSORPTION IN SYNTHETIC CITRINE.

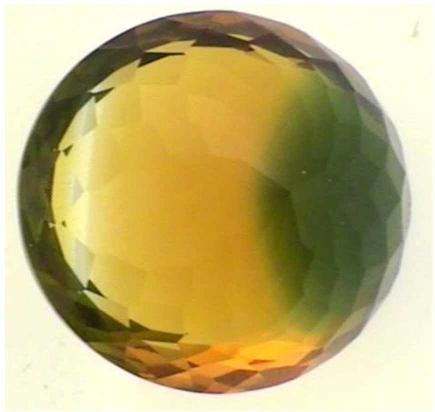
MAGNIFICATION

The typical eye-clean appearance of quartzes, particularly hydrothermal synthetics, is the main challenge to gaining visual clues. The lack of inclusions and other noticeable visual features requires patient and intensive microscopic work in order not to miss any clue.

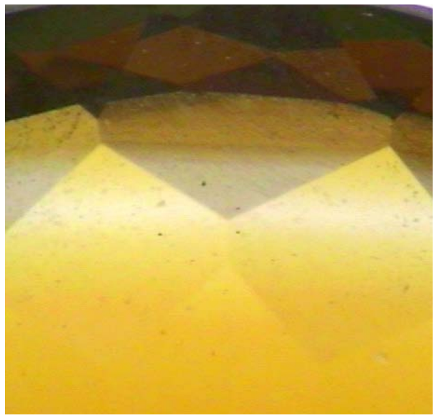
Unpolished, rough, synthetic quartz can be easily identified by 'growth hillocks' over the surface. These growth marks were not observed in natural stones and are considered diagnostic for hydrothermal quartz. Once polished, the identification work, which relies on inclusions and other internal visual features, becomes much harder and inconclusive.

Another diagnostic feature of synthetic origin is the presence of a seed crystal, commonly in the form of a fragment or flat plate. The seed crystal is usually colourless and seen best through immersion (Thomas Hainschwang, Gemlab). The presence of the seed crystal within the stone is more readily seen using a Chelsea colour filter (CCF). Under the CCF, the difference in colours will be more distinct; the seed crystal, commonly of rock crystal, displays a yellowish-green colour, while amethyst shows a very light pink and citrine yellow to orangey-yellow (C. Gunnarsson, Distinguishing Between Natural and Synthetic Quartz).

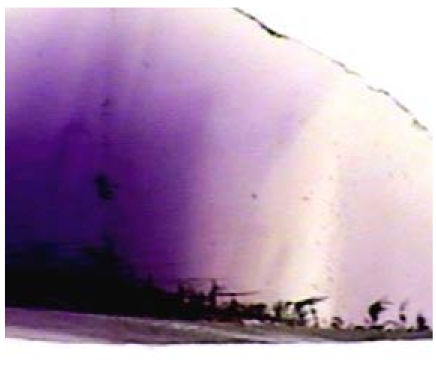
In rare cases, a trace of the platinum wire, which was used to hold the seed during growth, can be seen as an inclusion. An additional visual feature of the seed, but rarer, is the 'heat shimmer' effect. It arises from an area of discontinuity between the seed and the overgrowth (M. O'Donoghue, Artificial Gemstones).



A ROUND BI-COLOUR SYNTHETIC QUARTZ SHOWING COLOURLESS SEED PLATE.



A ROUND SYNTHETIC CITRINE SHOWING COLOURLESS SEED PLATE.



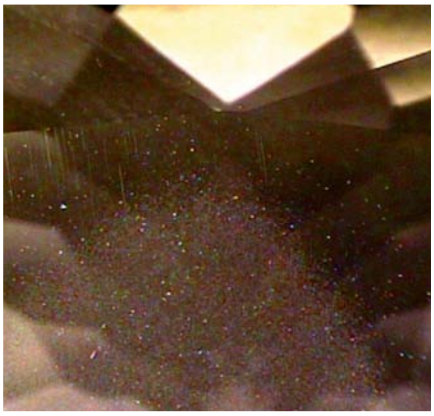
A SYNTHETIC AMETHYST FRAGMENT SHOWING COLOURLESS SEED CRYSTAL.

'GROWTH HILLOCKS' ON SYNTHETIC ROCK CRYSTAL ROUGH SURFACE.

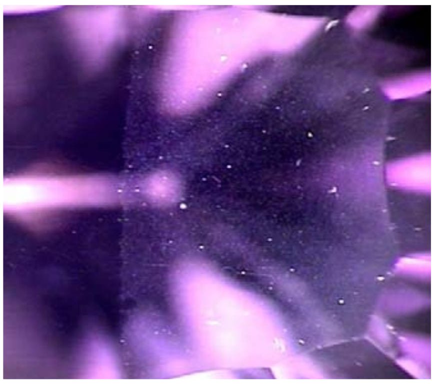
A TRACE OF THE PLATINUM WIRE IN SYNTHETIC ROCK CRYSTAL.

One of the most common features in synthetic quartz is 'bread crumb' inclusions. These tiny crystals, forming as individuals or in clusters, are believed to be sodium-iron silicates (M. O'Donoghue, Artificial Gemstones), likely a side effect of the growth solution during the synthesis. These inclusions were observed in some synthetic quartz as white to yellowish cloudy or grained planes inside the stone. The planes were oriented parallel to the seed plate (R. Crowningshield, C. Hurlbut and C.W. Fryer, Gems & Gemology Fall 1986). Bread-crumb inclusions have also been observed in natural amethysts, but only rarely.

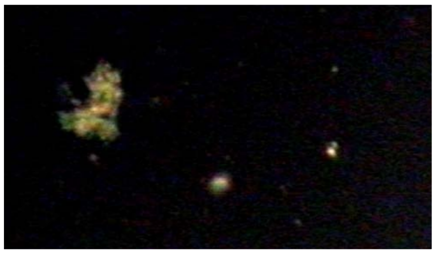
Other common inclusions, regarding all synthetic hydrothermal stones, are the 'nail-head spicules'. These long, narrow two-phase inclusions result from a growth blockage. They commonly present one end pointed and the other flat or gradually crumbled. The nail-head spicules are oriented perpendicular to the seed surface with the sharp edge pointing back to it. Again, spicules have been observed in natural quartzes as well, but only rarely.



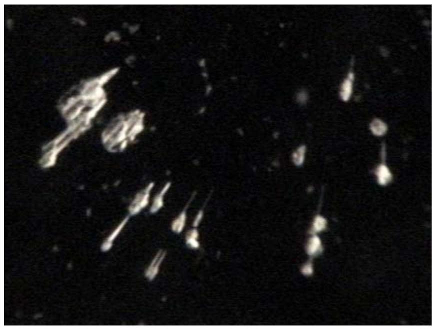
ABUNDANCE OF BREAD-CRUMB INCLUSIONS IN SYNTHETIC CITRINE.



BREAD-CRUMB PLANE IN SYNTHETIC AMETHYST.



A BREAD-CRUMB CLUSTER IN SYNTHETIC ROCK CRYSTAL.

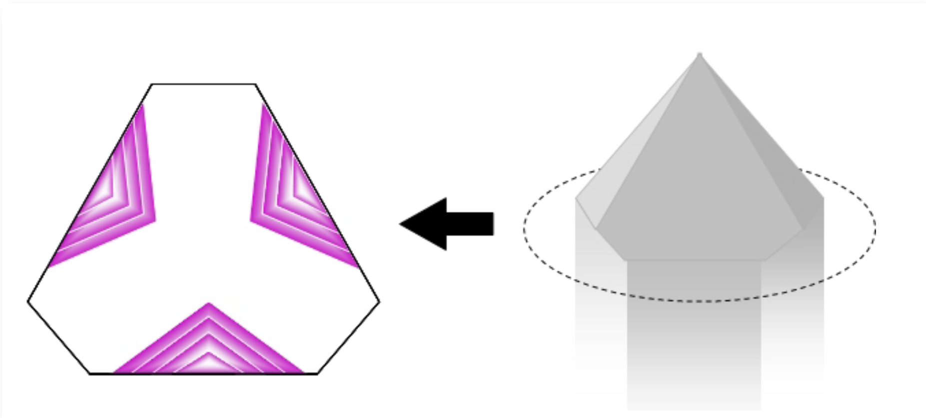


NAIL-HEAD SPICULE INCLUSIONS IN SYNTHETIC ROCK CRYSTAL, SHOWING POINT AT ONE END.

Liquid filled 'finger print' inclusions have been considered as evidence of natural origin; however, there have been reports of synthetic quartzes containing fingerprints. The fingerprints were reported to be typically near the surface of the crystal (R. Crowningshield, C. Hurlbut and C.W. Fryer, Gems & Gemology Fall 1986).

POLARISCOPE

One of the more common techniques used for distinguishing between natural and synthetic quartz is the twinning pattern. Under crossed polarizing filters, natural quartzes commonly show the 'Brazil twinning' interference colour pattern. This pattern, which looks like straight or triangular striations, results from alternate lamellar twining, mostly under the major rhombohedron, the triangular face that terminates the quartz crystal (R. Crowningshield, C. Hurlbut and C.W. Fryer, Gems & Gemology



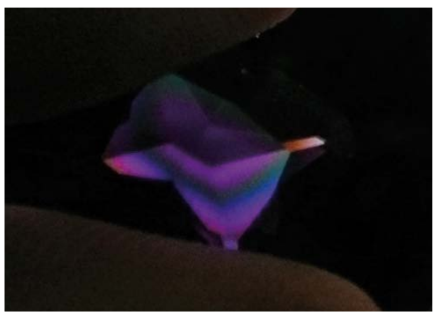
A SCHEME OF NATURAL QUARTZ CRYSTAL SHOWING THE LOCATION OF THE BRAZIL-LAW TWINING UNDER THE MAJOR RHOMBOHEDRON FACES.

Fall 1986). The twinning is arranged along the same orientation as the colour banding of the stone.

The synthetic quartzes, which rarely exhibit lamellar twinning, most always present regular interference colours. Some, which were slightly twinned during crystallization, may exhibit 'amorphous', 'arrow heads' or 'flame-like' pattern (R. Crowningshield, C. Hurlbut and C.W. Fryer, Gems & Gemology Fall 1986). Thomas Hainschwang (Gemlab) reported on a synthetic ametrine showing the 'flame-like' pattern with different orientations in each colour area.

Although there are recorded cases of synthetic quartzes displaying 'Brazil twinning' pattern (J. Koivula and E. Fritsch, Gems & Gemology Fall 1989), it is rarely seen and its presence could aid in identifying suspicious stones. However, a lack of twinning cannot be used as proof of synthetic origin, because some natural stones are cut from the area under the minor rhombohedron, which does not naturally grow as twinned. In addition, natural amethysts from Brandberg (Namibia) were reported that did not exhibit twinning (Thomas Hainschwang, Gemlab).

A SYNTHETIC CITRINE SHOWING FLAME-LIKE PATTERN UNDER CROSSED POLARIZING FILTERS.



A SYNTHETIC AMETHYST SHOWING EVEN COLOURED LINES PATTERN UNDER CROSSED POLARIZING FILTERS.

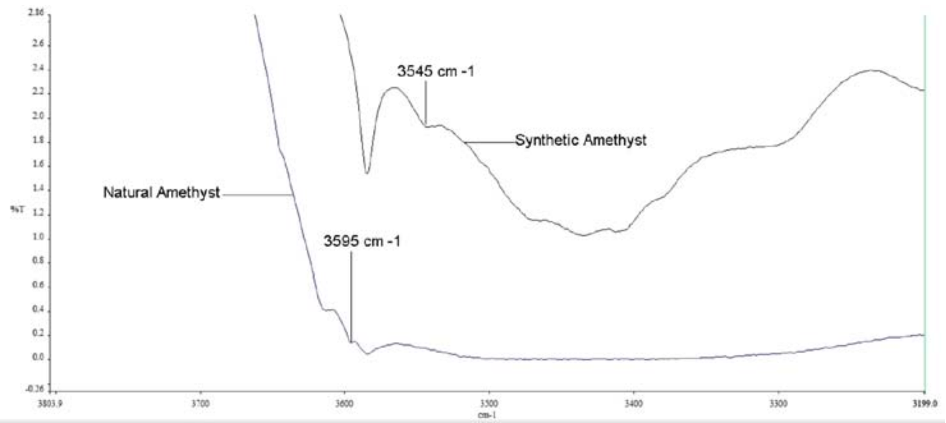
Another technique using polarizing filters utilizes the conoscope rod (also known as condensing sphere). Although there are no conclusions about its usefulness to distinguish between the two origins, unusual results were seen and should be mentioned. Natural quartzes, which are anisotropic, exhibit a uniaxial interference figure or the diagnostic quartz "bull's eye" interference figure. In synthetic quartzes, reports have shown varied responses. While some synthetic citrines show bull's eye effect, there are no reports for the same in synthetic amethysts. There is even one report of ametrine presenting a bull's eye response from the citrine side and an Aries spiral uniaxial response from the amethyst side (Bear Williams, Stone group labs).

INFRA RED

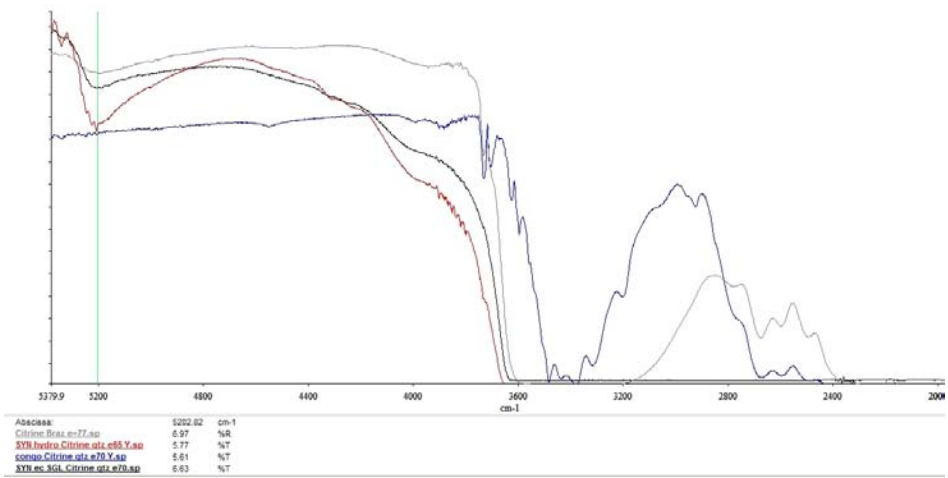
The FTIR is considered a laboratory instrument, one not accessible to most gemmologists; however, as prices continue to fall, it may become more accessible.

Hydrothermally grown synthetic amethyst can be grown in two different solutions. Amethyst grown in near-neutral NH4F solution commonly shows diagnostic absorption bands at 3680, 3664 and 3630 cm-1. Unfortunately, few of the commercial quality synthetic amethysts are grown by this method (C. Gunnarsson, Distinguishing between Natural and Synthetic Quartz).

The more popular method for synthesizing amethysts is the alkaline solution K2CO3. An absorption band at 3543 cm-1 was observed in the majority of synthetic amethyst. However, there have been reports of synthetic stones that do not show the 3543 cm-1 peak, and also of rare, natural stones that do show it. Another useful identifier is the 3595 cm-1 band, which is commonly seen in some natural stones but only rarely in synthetics (C. Gunnarsson, Distinguishing between Natural and Synthetic Quartz).



AN FTIR SPECTRAL ANALYSIS OF NATURAL AND SYNTHETIC AMETHYST SHOWING THE 3543 AND 3595 CM-1 ABSORPTION PEAKS.



AN FTIR SPECTRAL ANALYSIS OF TWO NATURAL CITRINES REPORTEDLY FROM CONGO (BLUE) AND BRAZIL (GREY) AND TWO SYNTHETIC CITRINES (BLACK AND RED).

CONCLUSION

Without sophisticated laboratory equipment, except in cases of diagnostic evidence, such as the presence of a seed crystal or the mounds-like surface of rough, it is almost impossible to distinguish conclusively between natural and synthetic quartz gems.

However, an experienced gemmologist can carefully collect all visual clues (colour distribution, inclusions, twining pattern and FTIR spectra) and combine these to create a strong body of evidence as to the nature of a gem's origin. Except in cases of obviously unnatural body colour, the nature of inclusions, infrared absorptions and twinning pattern should have the greatest influence on the final judgment.

BIBLIOGRAPHY:

Books:

Michael O'Donoghue\ Artificial Gemstones pages 197-204.

Articles:

Robert Crowningshield, Cornelius Hurlbut and C.W. Fryer \ A simple procedure to separate natural from synthetic amethyst on the basis of twinning \ Gems & Gemology Fall 1986.

John I. Koivula and Emmanuel Fritsch \ The growth of Brazil-twinned synthetic quartz and the potential for synthetic amethyst on the Brazil law \ Gems & Gemology Fall 1989.

Thomas Hainschwang \ Synthetic quartz overflowing the market \ Gemlab newsletter 08/2007.

Thomas Hainschwang \ More synthetic quartz passing through the lab – large synthetic ametrines submitted for ID \ Gemlab newsletter 05/2008.

Past projects:

Camilla Gunnarsson \ Distinguishing between Natural and Synthetic Quartz 2008.

FTIR spectra graphs:

Bear Williams 'Stone Group Labs'

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