Lead glass filled star rubies reportedly from Madagascar

A preliminary examination and a comparison with star rubies from other deposits.

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Figure 1: A selection of 34 lead glass filled star rubies showing the color range of the new material from pink to red and to near black. The stones in the photograph weight from approximately 1 to 20 carats. The photograph was taken using a slightly diffused natural sunlight in Bangkok, Thailand. The background used is page 17 of "Gemstone Enhancement" by Kurt Nassau (1984). Photo: V. Pardieu / GIA Laboratory Bangkok

Introduction: Meeting the Thai burner.

In January 2010 the GIA Laboratory Bangkok was contacted by Mr. Mahithon Thongdeesuk (Figure 2), from "Jewel enhancement by Mahiton Co. Ltd" in Bangkok, a Thai burner involved in the development of the lead glass treatment since 2002. He informed the authors that he had finished developing a new product which he will soon release in the Thai market: "Lead glass filled star rubies" (Figure 1, Figure 5 and Figure 6)

Mr. Thongdeesuk informed the GIA gemologists visiting his factory that the material used for this treatment originated from Madagascar. He also told us that he and his partners have now finished treating and polishing about 100 kilos of this new lead glass treated product which will soon be available in the market at a fraction of the price of similar looking untreated gem material.

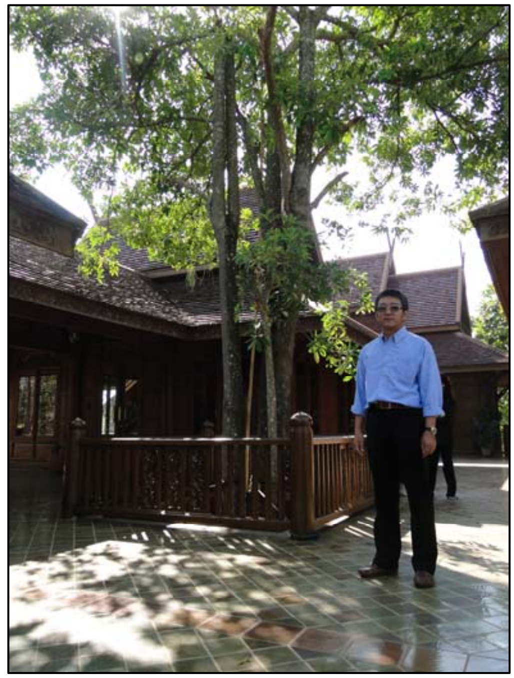

Figure 2: Thai gemstone burner Mr. Thongdeesuk at his house in Thailand. Photo: Mahiton Thongdeesuk

Mr. Thongdeesuk was interested in collaborating with the GIA Laboratory in order for GIA gemologists to produce an independent study of his new product for publication prior to the product's availability to the trade. Mr. Thongdeesuk main concern is that whilst the Thai gem trade is very aware of treatments, it is not the same in the rest of the world and he is concerned that once his new product, to probably be marketed in Thailand under the name "star ruby paw mai" meaning "star ruby new treatment" or "star ruby lead glass", is released onto the market, it might not be marketed accurately. He expressed particularly concern about the best looking transparent bright pinkish red material that some people may mistake for untreated star rubies from traditional sources like Mogok (Burma).

He felt that the best way to launch his new product is to collaborate with the GIA so that accurate information about the material can rapidly be released to the markets. In this way he hopes that this will set a good example for other gem burners and show them that collaboration with gemological laboratories can not only help to protect the final consumer, Thailand's reputation and those of its Thai gemstone burners, but also promote new products and help them find their place in the global trade without unnecessary controversies.

Mr. Thongdeesuk also mentioned that he is currently building an informative website about lead glass filled rubies with an emphasis on how to identify them and how to take care of them.

Lead glass: An historical background:

Lead glass is a lead rich glass where lead is used to replace calcium and produce high refractive index glass. Men discovered how to make lead glass long time ago as some lead glasses are known from the antiquity. Nevertheless fine transparent qualities started to be produced on an industrial scale at the end of the 17th century in England by Charles Ravencroft and soon factories opened all over Europe and beyond. Today several factories in Europe, Asia and in the USA produce lead glass for its decorative properties. The products are commonly sold as *lead crystal* or even more often simply *crystal* even if technically, the term *crystal* should not be applied to glass, as glass, by definition, lacks a crystalline structure. The use of the term *crystal,* even if it is scientifically very controversial, remains popular for historical and commercial reasons.

The use of lead glass to fill fissures in gemstones is more recent process. Lead (or bismuth) rich glass was first used to fill drill-holes and fissures in diamonds during the 1980's with a process developed by Zvi Yehuda of Ramat Gan, Israel in 1982 (Kammerling*, et al.*, 1994).

The glass filling of fissures and cavities in ruby followed (Scarratt, 1988). Finally lead glass filled rubies became very common in the markets at the end of 2004 when Mr. Thongdeesuk and several other Thai burners applied this method to rubies from the Andilamena ruby mining area in Madagascar (Pardieu, 2005, GAAJ, 2004). Whilst star rubies filled with lead glass are not new, they have been available since the beginning of the treatment (GAAJ, 2004, Hainschwang, 2009, Pardieu, 2006), such stones have remained relatively rare, yet with the arrival of this new treated material from Madagascar the situation could well change and lead glass filled star rubies might be encountered more often in the markets.

Clarity enhancement with lead glass:

The technical interest of glass filling is that it optically hides fissures and fills cavities which occur naturally in most gemstones. This enables the light to pass through the filled areas. Since the fractures don't act like mirrors anymore, the light path becomes longer enabling the color of the stone to appear more saturated (Figure 3). The result of the treatment is often very stunning as heavily fractured, very low grade pink looking material can look like a fine non-fractured red gem after treatment (Figure 3).

Figure 3: Left: Rough ruby material from Andilamena as found at the mines. Center: The same Andilamena material after cleaning fissures with acid and a preliminary heat treatment step without additives in order to clean the fissures to enable the final lead glass treatment. Right: The same Andilamena ruby material after the final heat treatment with lead glass. Photos: V. Pardieu / AIGS, 2005

The binding property of the glass also enables the treated material to be cut and polished more easily. Mr. Thongdeesuk told us that the cutting and polishing of untreated heavily fractured material would not be possible as the stones would probably break in the process. This treatment enables low quality fractured material to find a market in the gem trade as a much cheaper alternative to non-fissured fine quality gemstones.

Nevertheless for filled stones in general and lead glass filled rubies in particular durability remains a serious issue. It is a fact that, in comparison with ruby, lead glass can easily be damaged by chemicals (acids, caustic soda...), has a lower melting point, is very brittle, and can be damaged easily if the lead glass filled stones are not handled with particular care. Thus it is particularly important that the true nature of these lead glass filled stones is disclosed, and furthermore the buyer should be informed about how to take care of this treated material.

For star rubies there is another interesting point to note: Since the lead rich glass used to fill the fissures and cavities inside the stones has a relatively low melting point, most of the inclusions, like the rutile needles responsible for the star effect, are not affected by the treatment (Figure 4). As a result the final product can exhibit a six (or twelve) rayed star very similar to that found in non-fractured, untreated star rubies. But of course, as with most low temperature treatments, this can create some serious identification challenges for the gemologist trying to identify the treatment.

Figure 4: A glass filled cavity in a star ruby studied using overhead lighting. The numerous rutile needles were not affected by the glass filling process as the glass melting point is lower that the temperature necessary to affect them. Photo: V. Pardieu / AIGS, 2006

The result is visually interesting since the stars seen on these lead glass filled star rubies are usually very similar to those seen on untreated material. So for the observer not aware of the existence of such treatment, the identification of the new material in market or field conditions might be more challenging than the identification of diffused or synthetic star stones where the stars produced are typically “too good to be true”.

Nevertheless a trained gemologist with the right laboratory equipment will be able to identify the stones properly as a lead glass filled rubies, as we will see later in this study.

Figure 5: Lead glass filled rubies reportedly from Madagascar seen under slightly diffused natural sunlight. About 10% of the material from the mine can reportedly be turned into this transparent red star material after lead glass treatment, with the rest of the production being less transparent or darker. Photo: V. Pardieu, GIA Laboratory Bangkok, 2010.

Gemological description of the "lead glass filled star ruby" material

Description of the stones studied:

The GIA Laboratory in Bangkok selected 34 lead glass filled star rubies at Mr. Thongdeesuk office in Bangkok, on January 18th 2009. The stones weighed from approximately 1 to 20 carats and their color from pink to red and to very dark red. Most of the stones had a slight brownish or purplish aspect, but some stones showed a bright red color (Figure 5, Figure 6). Silk, as white bands was visible in most of the stones reminiscent of the "Kin Bo Tian" type star rubies commonly found in Mogok, Burma. All the stones displayed a six rayed star, and one very dark stone a twelve rayed star.

Figure 6: Several small parcels of lead glass filled rubies showing the different qualities produced by this treatment using as base ruby rough material reportedly from a single (still undisclosed) area in Madagascar. The stars are not visible here as the sky was cloudy; nevertheless the colors are representative of the stones seen at the burner's office. Photo: V. Pardieu, GIA Laboratory Bangkok, January 2010.

UV Fluorescence

The 34 lead glass filled star rubies (Figure 1) were observed under both short wave and long wave ultra violet light using a UVP, UVLS-28 EL series, 8 watt, UV lamp with both 365 and 254nm radiation. Their reactions (Table 1) were found to be more subdued when compared to the strong reaction commonly found in iron poor rubies like those from Burma and quite similar to other iron rich rubies from East Africa and Thailand/Cambodia.

Table 1:

SWUV (253nm)	Inert (dark red stones) to weak red to orangy-red (bright red stones)
LWUV (365nm)	Weak to moderate (dark red stones) to strong red to orangy-red (bright red stones)

Chemistry

The chemistry of the lead glass filled star rubies reportedly from Madagascar was analyzed using an Energy Dispersive X-ray Fluorescence (EDXRF) spectrometer. The instrument employed was the Thermo Fisher Scientific ARL Quant'x, using fundamental parameters (Theoretical) and in-corundum elemental standards.

EDXRF is a very convenient instrument to use for the detection of heavy elements such as lead, bismuth or barium, commonly used in the fabrication of high refractive index glass such as the "lead glass" used to fill fractures gemstones. EDXRF can also provide some semi-quantitative data that is useful for gemologists trying to determine the geographic origin of a given ruby.

Two different analytical methods were used to analyze each stone:

- In the first method the elements Ti, V, Cr, Fe, and Ga were analyzed using a semi-quantitative method useful for origin determination (see table 2 to 6).
- In the second method a thin copper filter was added in order to obtain better results for heavy elements like lead (Pb).

Using both methods the presence of lead was detected in all samples:

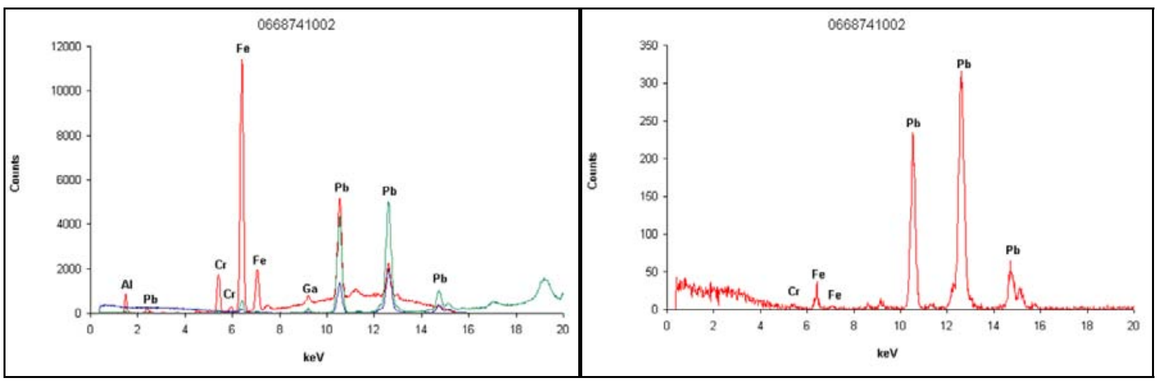

Figure 7: EDXRF analysis of sample 0668741002 using the semi quantitative method (left) or using a copper filter (right). The presence of lead is easily detected in both cases.

The following five stones were selected for study in this preliminary examination:

Table 2: Stone 0668741102: Transparent red lead glass filled star ruby, 1.569cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.034	0.015	0.321	0.701	0.019
elemental ppmw	203.6	86.2	2201	4909	141.9
elemental ppma	86	34	863	1792	41

Table 3 Stone 0668741002: translucent silky pinkish red lead glass filled star ruby, 1.682cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.014	0.004	0.130	0.437	0.021
elemental ppmw	86	26	891	3060	159
elemental ppma	36	10	349	1117	46

Table 4: Stone 0668740802: translucent silky red lead glass filled star ruby, 2.181cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.031	0.009	0.408	0.654	0.020
elemental ppmw	186	54	2794	4691	150
elemental ppma	79	21	1095	1712	43

Table 5 Stone 0668740602: Translucent purplish red lead glass filled star ruby, 17.107 cts

units	Ti	V	Cr	Fe	Ga
oxide wt %	0.059	0.006	0.408	0.667	0.011
elemental ppmw	354	36	2742	4670	84
elemental ppma	150	14	1075	1705	24

Table 6 Stone 0668740702: Very dark purplish red lead glass filled star ruby, 8.611 cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.034	0.012	0.278	0.805	0.023
elemental ppmw	204	67	1903	5606	172
elemental ppma	86	26	746	2046	50

The quantitative data obtained provides some insight into their source type and helps with regards to their origin determination. Their chemistry is characterized by relatively high levels of iron compared to known star rubies from traditional marble type deposits like Mogok (Burma) and Vietnam meaning that these rubies host rock is probably not marble. Thus chemistry seems to be a reliable method to separate these lead glass filled star rubies of reportedly Madagascar origin from star rubies from these traditional Asian deposits.

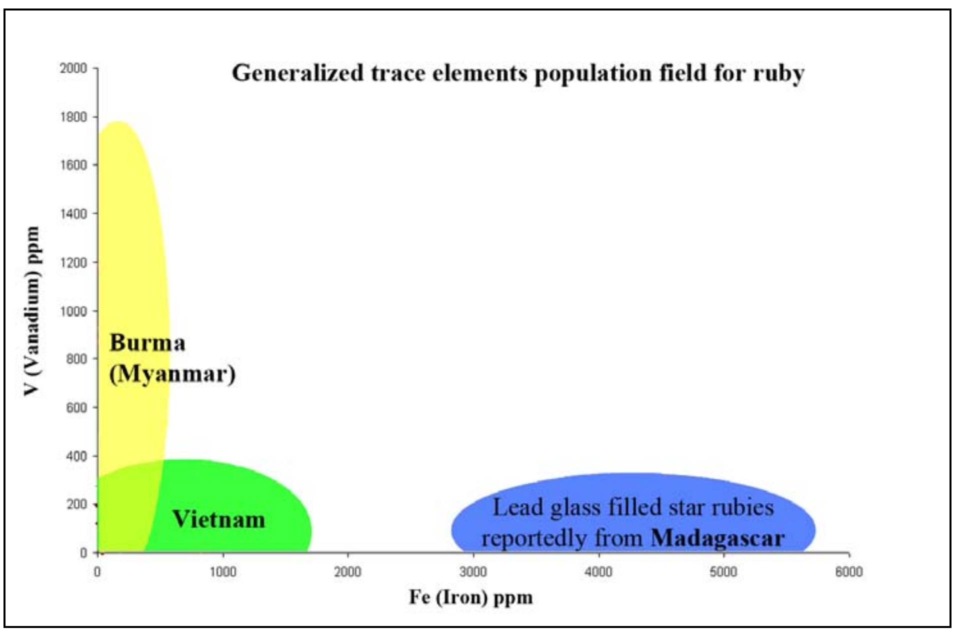

Figure 8: Comparison of the chemistry (V to Fe ratio) between lead glass filled rubies reportedly from Madagascar with untreated rubies from Mogok (Burma) and Vietnam using EDXRF spectrometry.

Infrared spectrometry:

Infrared spectra were collected on the five lead glass filled star rubies selected for this preliminary study using a Thermo Nicolet 6700 FTIR[1] spectrometer and appropriate accessories:

All the samples studied recorded broad bands around 2600 and 3500 cm-1 (Figure 8) reportedly associated with the presence of lead glass in the filled fissures and cavities (GIT, 2007, Panjikar).

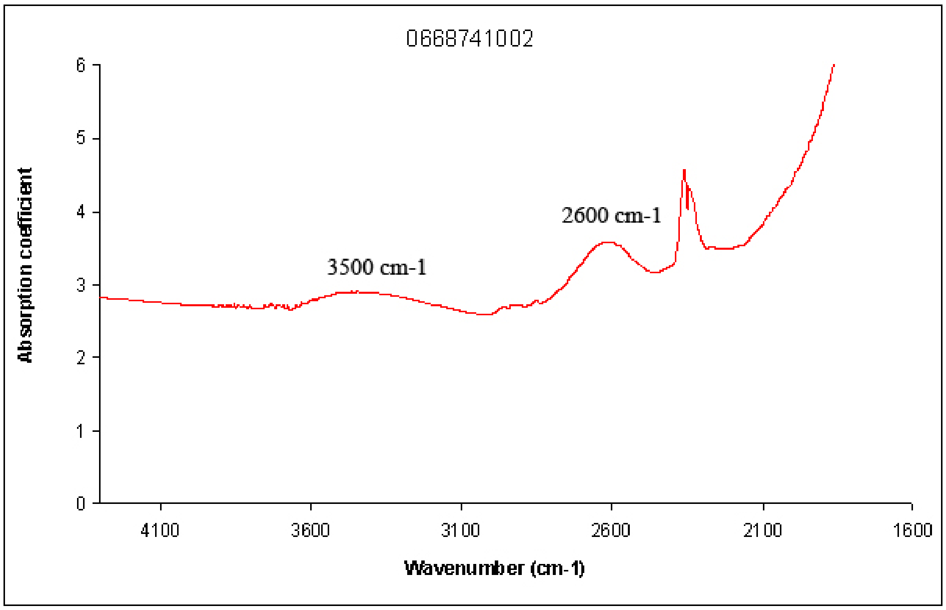

Figure 9: FTIR spectrum of a lead glass filled ruby exhibiting clear broad bands at 3500 cm-1 and 2600 cm-1.

Examination of inclusions in market and laboratory conditions:

The lead glass filled star rubies were studied with the microscope in laboratory conditions and using a 10x triplet loupe in field conditions:

Using the 10 x loupe in field conditions the proper identification of most of the stones studied was often found to be very challenging compared to the faceted lead glass filled rubies seen in the market since 2004:

- First, the lack of transparency of most of the lead glass filled star rubies, due to the presence of dense silk in most of the stones, made the study of the fissures more difficult (Figure 10, Figure 11, Figure 12): Thus finding flattened gas bubbles was harder compared to transparent faceted more traditional lead glass filled material.

[1] FTIR: Fourier Transformed Infra-Red spectrometry

- Furthermore the flash effect commonly seen in many faceted lead glass filled rubies was absent in all the stones studied.

- In the stones studied the filled fissures and cavities were not easy to spot using overhead lighting as the refractive index (RI) of the lead glass used for this treatment seems to be very close to the ruby's own refractive index (Figure 12, Figure 13). This differs to the glass filled fissures and cavities where the glass has a refractive index further away from the ruby host (Figure 4).

Figure 10: The identification of the flattened gas bubbles is challenging due to the presence of dense silk. Photo: V. Pardieu

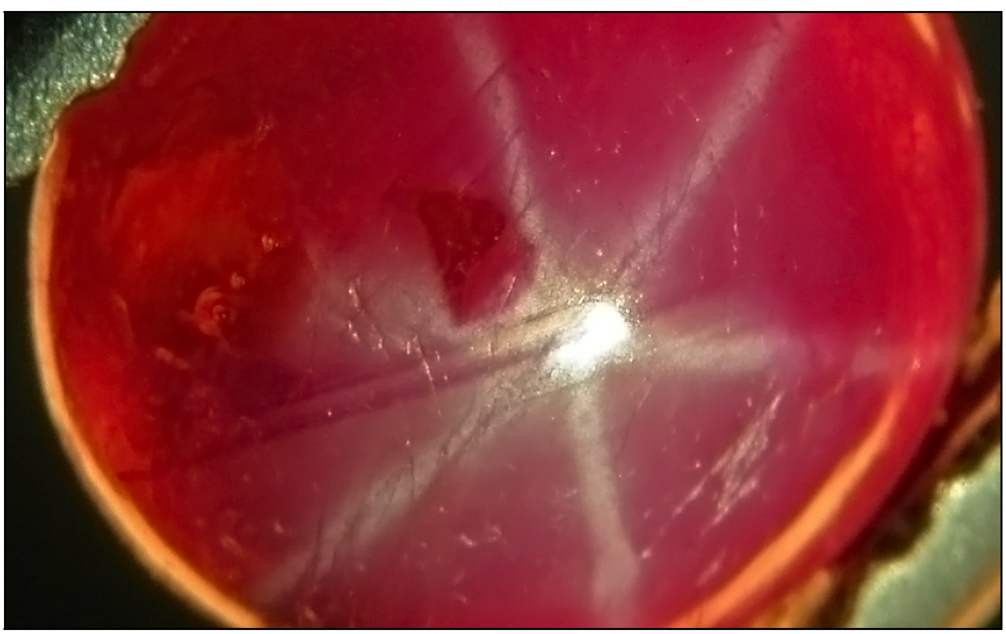

Figure 11: In stones like this one the presence of large cavities filled with glass, containing large spherical gas bubbles (left of the stone) can help to identify the presence of glass filling. Nevertheless the luster difference is not obvious and in such milky stones the examination of the fissures is difficult. Photo: V. Pardieu.

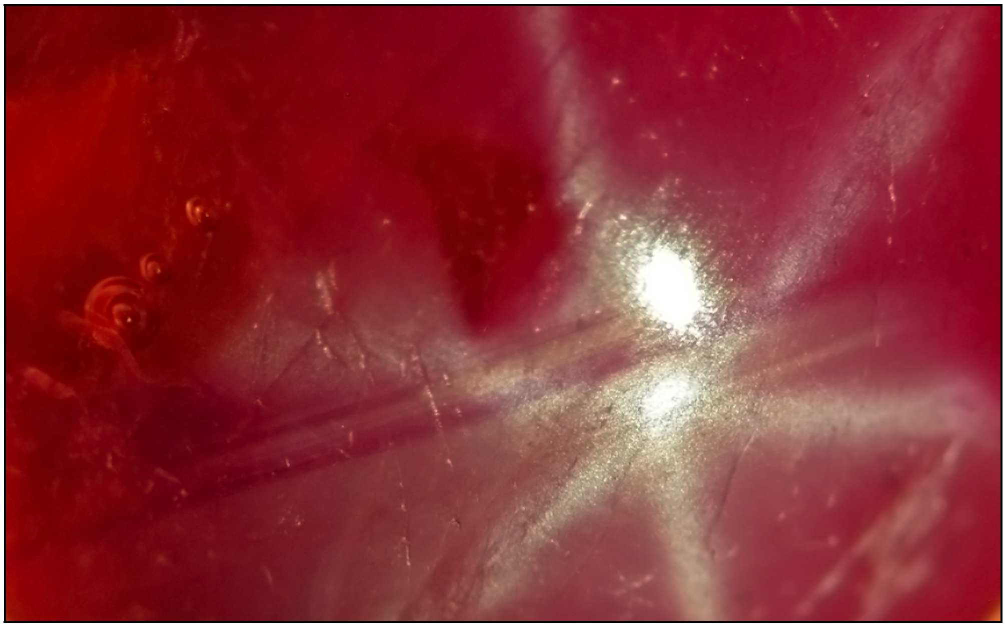

Figure 12: A closer view of the previous stone. Whilst the gas bubbles are more obvious here the examination of the surface does not reveal obvious differences in luster between the ruby and the glass filled fissures and cavities. Photo: V. Pardieu

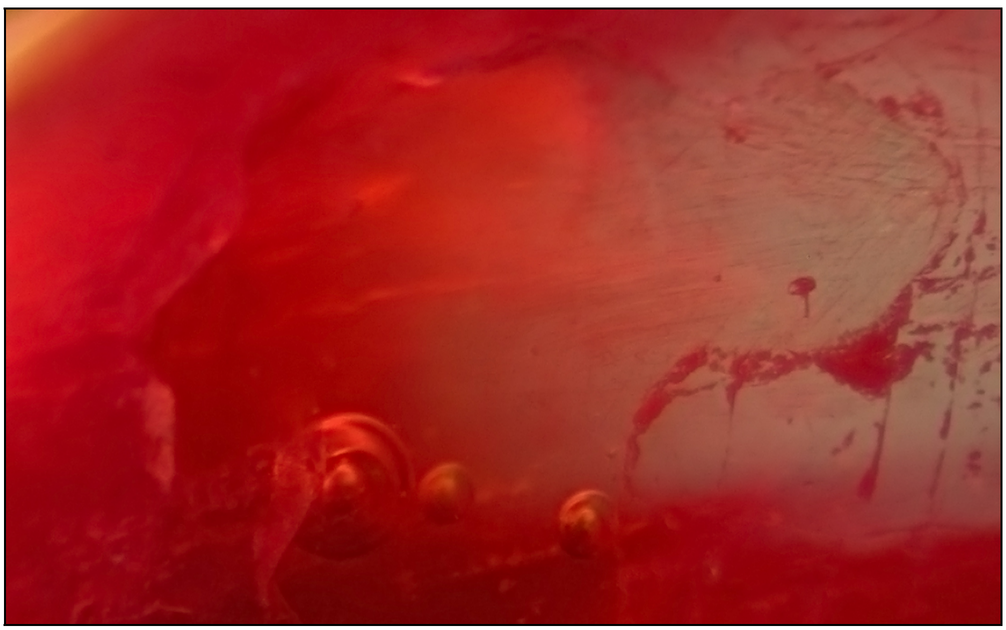

Figure 13: The identification of large glass filled cavities can also be challenging as the lead glass' refractive index is very close to the host's refractive index and the difference in luster is not obvious as shown here. Nevertheless in this example large gas bubbles are useful evidence to properly identify the presence of the glass filled cavity. However, this sample also shows that polishing has damaged some areas where the glass meets the ruby. Photo: V. Pardieu

Using the microscope, under laboratory conditions with more powerful magnification and better illumination the identification of these stones as lead glass filled rubies was much easier than with the 10x loupe:

The main inclusions were found to be very thin needles arranged in dense (and often white) bands (Figure 15) commonly associated with small particles arranged in a 30 degree orientation to those of the rutile needles (Figure 18). Crystal inclusions were not seen in the stones studied so far with the microscope.

The high density of the needles affect the transparency of stones and thus inclusions were difficult to see. However, when using proper lighting conditions the identification of flattened gas bubbles trapped in the main fractures were quite easy (Figure 14) to detect. Nevertheless, compared to faceted transparent lead glass filled rubies, the lack of flash effect colors associated with the fissures makes the identification of the treatment using the microscope a more challenging operation compared to the transparent faceted lead glass filled rubies more frequently encountered.

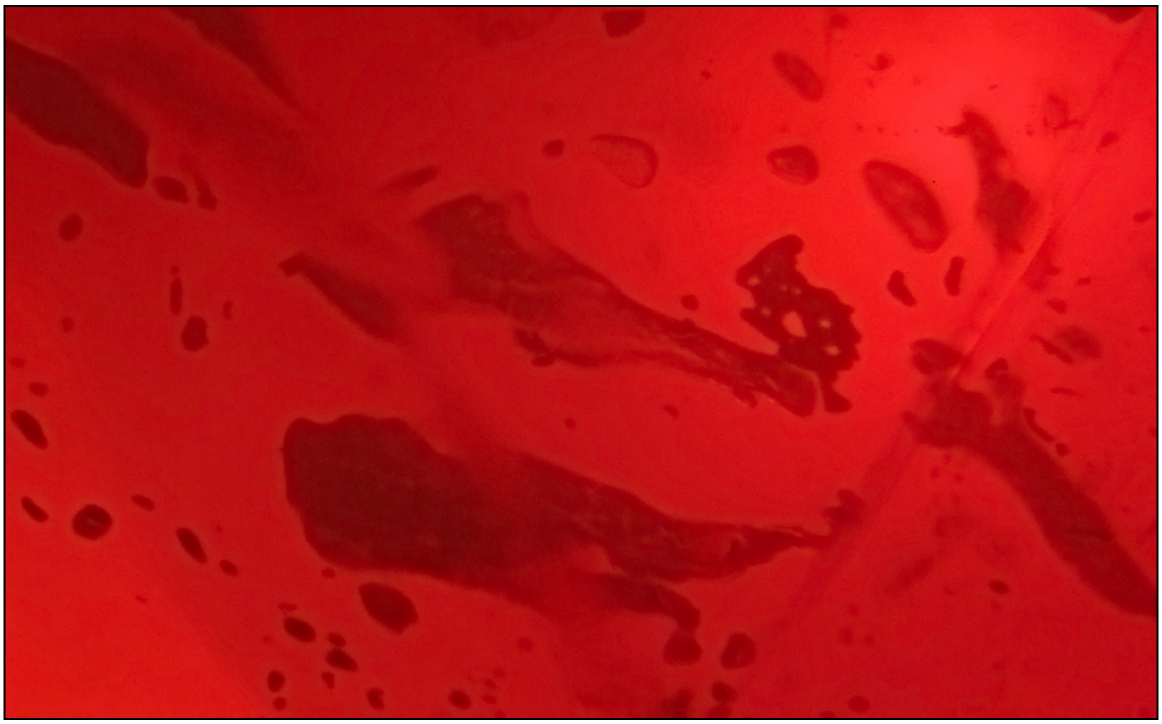

Figure 14: Large flattened gas bubbles seen when using bright field illumination can be found in most of the stones. Photo: V. Pardieu

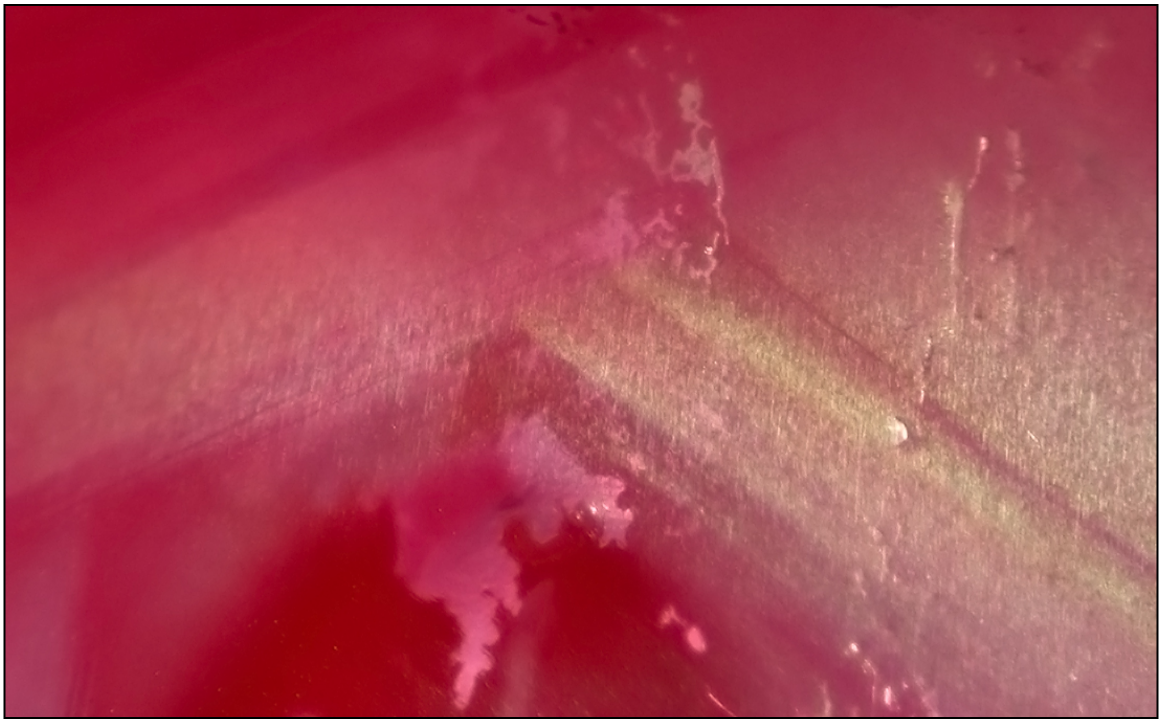

Figure 15: Using overhead lighting, the dense silk bands can be studied. In the lead glass filled rubies studied they are commonly composed of very tiny and thin needles. In this photo we can also see a large irregularly shaped gas bubble in a surface reaching fissure, but no difference in the surface luster is obvious where the fissure reaches the surface. Photo: V. Pardieu

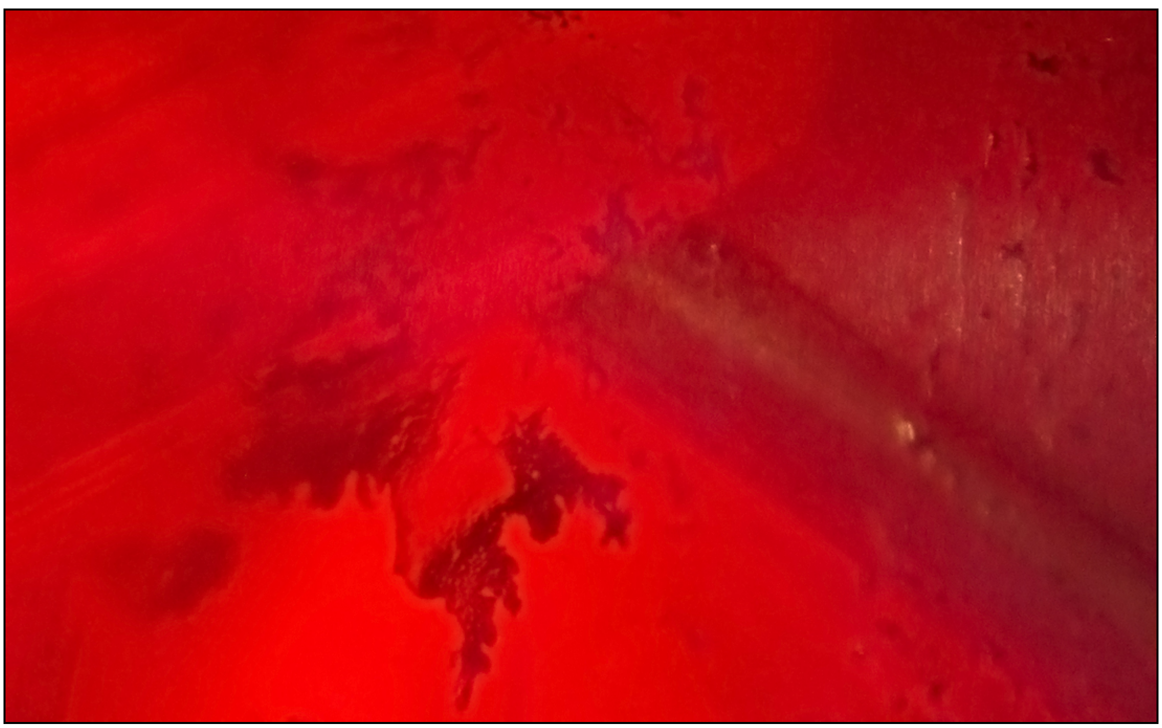

Figure 16: The same stone as in Figure 14 but using dark field conditions. Owing to the stone's lack of transparency the gas bubbles present are difficult to see. Photo: V. Pardieu

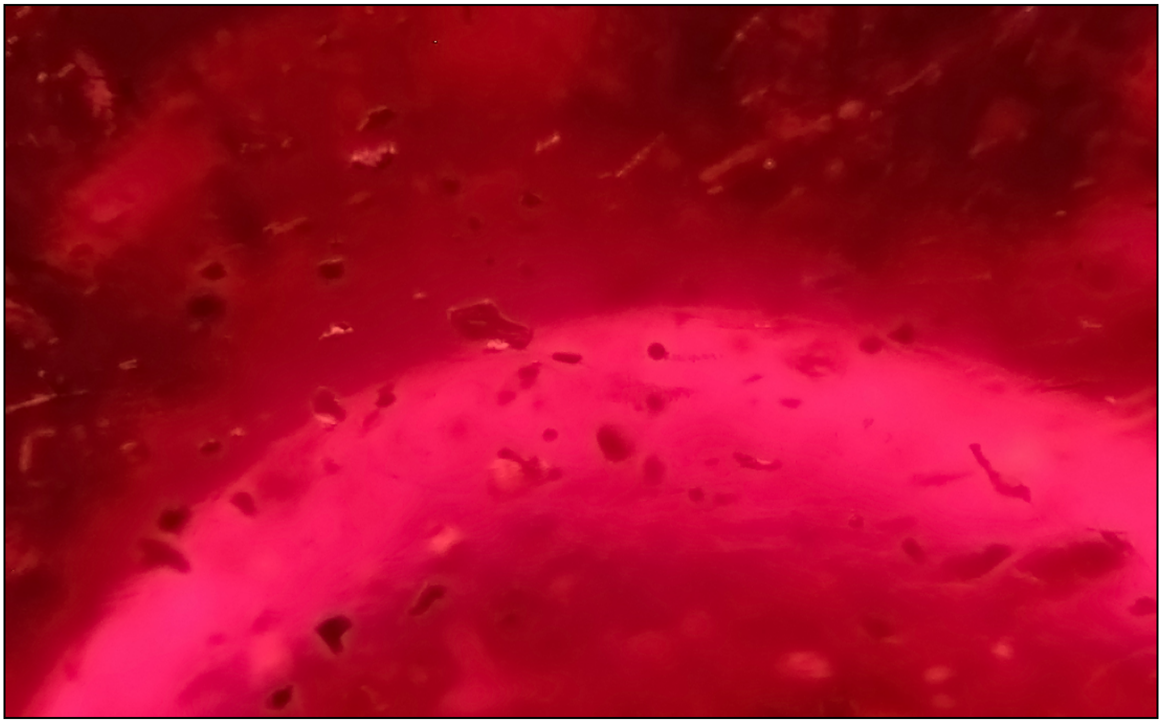

Figure 17: Using dark field illumination flattened gas bubbles are clearly visible inside this lead glass filled star ruby. Photo: V. Pardieu

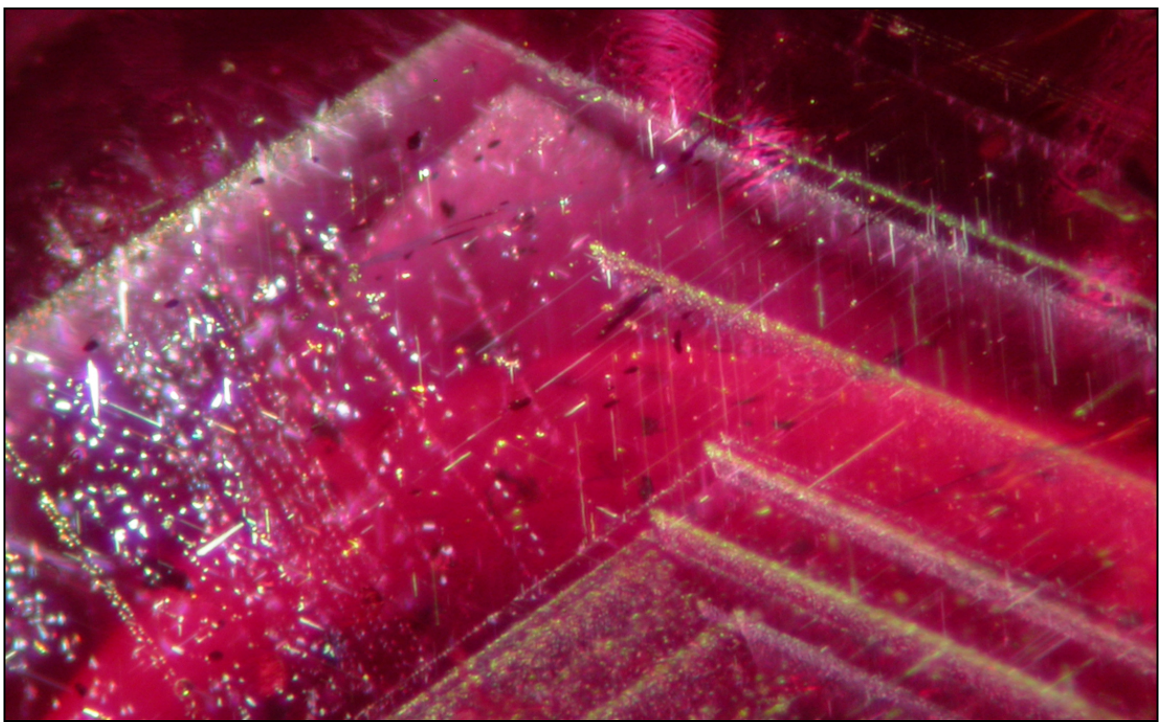

Figure 18: The same stone in the same position as in Figure 16, but here the photo was taken using overhead lighting conditions enabling the reflective and iridescent needles creating the star to be seen. Photo: V. Pardieu

X-Ray Micro-radiography:

Several lead glass filled star rubies were studied at the GIA Laboratory in Bangkok using a Faxitron CS-100's Real-time microradiography unit commonly used in the laboratory for pearl analysis. The unit was originally designed for the inspection of SMT assemblies, semiconductors and PCBs but is excellent for pearl and gemstone microradiography.

Studying lead glass filled stones using x-ray microradiography is an extremely useful method for clearly determining the quantity of lead glass actually present inside the stone. This method enables the examiner to clearly understand whether they are testing a "lead glass filled ruby", a "ruby with glass" or a "ruby-glass composite material" as per the protocols detailed in the nomenclature proposed by the LMHC[2] in the LMHC Information Sheet IS3 (See Annex A).

It shows also how efficiently the lead glass had penetrated the fissures during the heat treatment process (Figure 19, Figure 20, Figure 21 Figure 22). In the microradiographs the lead glass appears as white lines (filled fissures) or white areas (filled cavities).

After studying the microradiographs of the stones studied, it was clear that the samples examined were lead glass filled rubies and not an assembled material resulting from the bonding of several unrelated pieces of ruby material with glass. It appears that the lead glass used has no difficulty in filling very thin fissures and penetrates very deeply into the stones. Large gas bubbles can also clearly be seen within larger fissures.

The observation of the lead glass filled rubies from the top is usually not very revealing except when the stone contains cavities or significant, wide fissures (Figure 20). In such circumstances these filled fissures, along with their gas bubbles, are usually readily apparent. When examined from the side the stones are usually more interesting in that most of the glass filled fissures seems to be confined to oblique planes and other structurally orientated fissures. In this orientation numerous, and very often very thin, lead glass filled fissures became more visible (Figure 22).

Stone 0668741102:

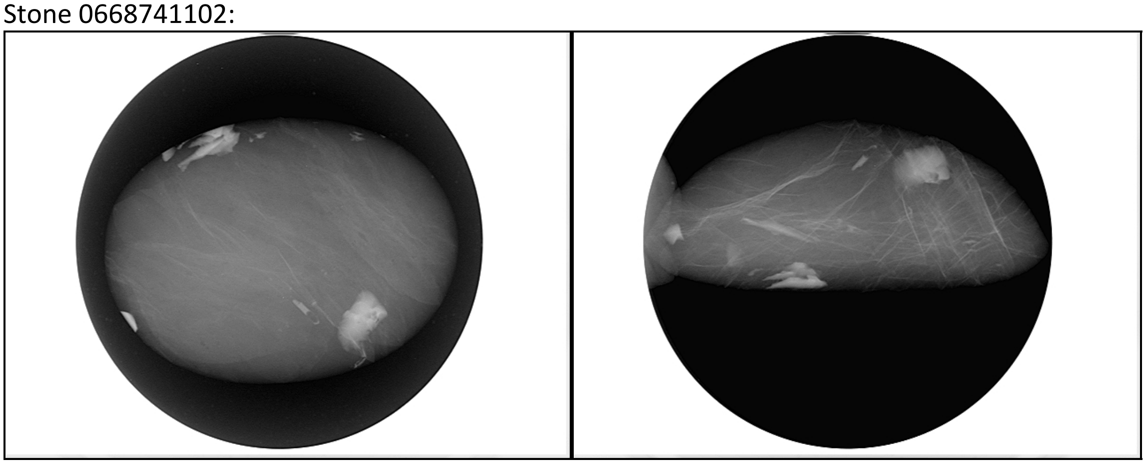

Figure 19: The stone has three main cavities filled with lead glass and from the side we can also see the lead glass filled fissures more clearly.

[2] LMHC: Laboratory Manual Harmonisation Committee

Stone 0668741002:

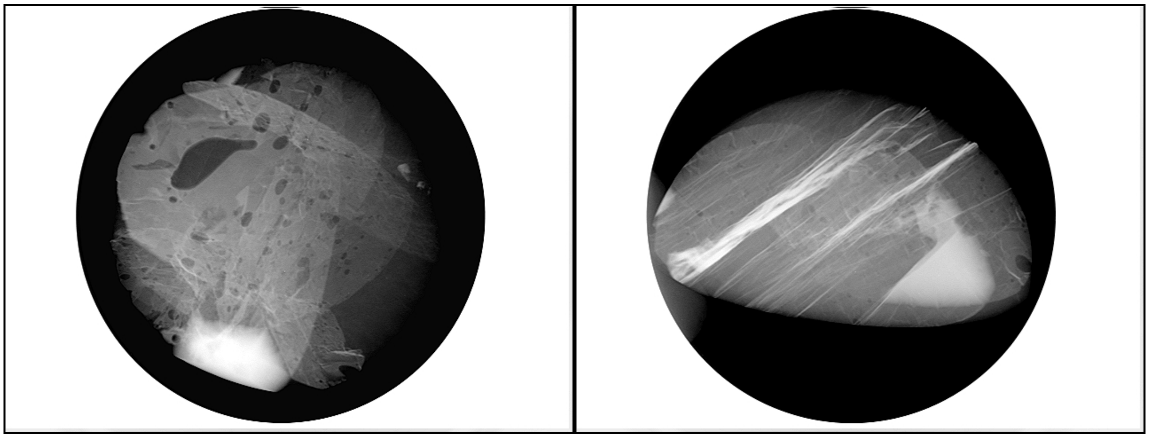

Figure 20: This stone shows several significant filled fissures and one large filled cavity (white area). From the top the gas bubbles contained in these significant fissures are obvious as dark rounded areas, while from the side the wide lead glass filled fissures appear as bright white lines while the thin fissures containing less lead glass are less visible. The dark bubbles being so flat and thin also disappear in the side-on direction.

Stone 0668740702:

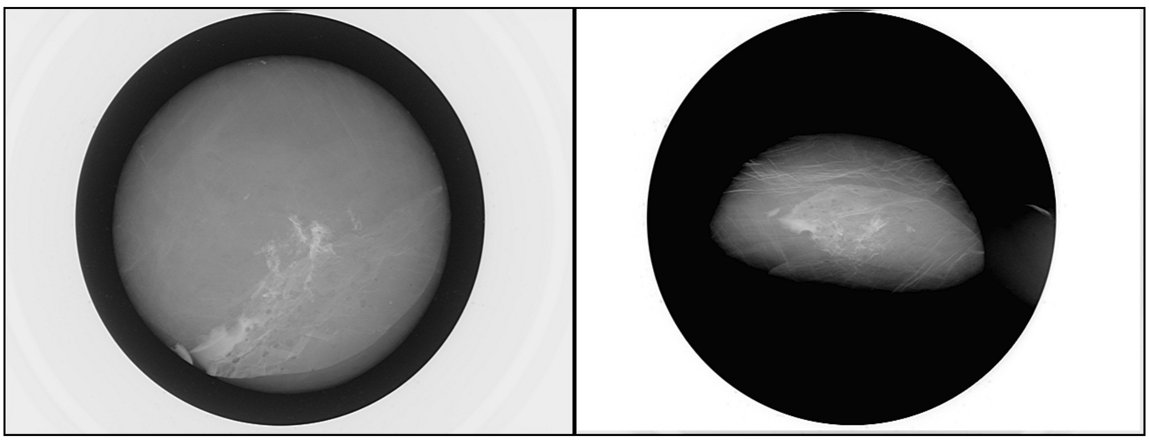

Figure 21: This lead glass filled star ruby presents one wide fissure containing several gas bubbles as seen from the top; the examination of the stone under X-Ray from the side enables to discover many thin lead glass filled fissures.

Stone 0668740602:

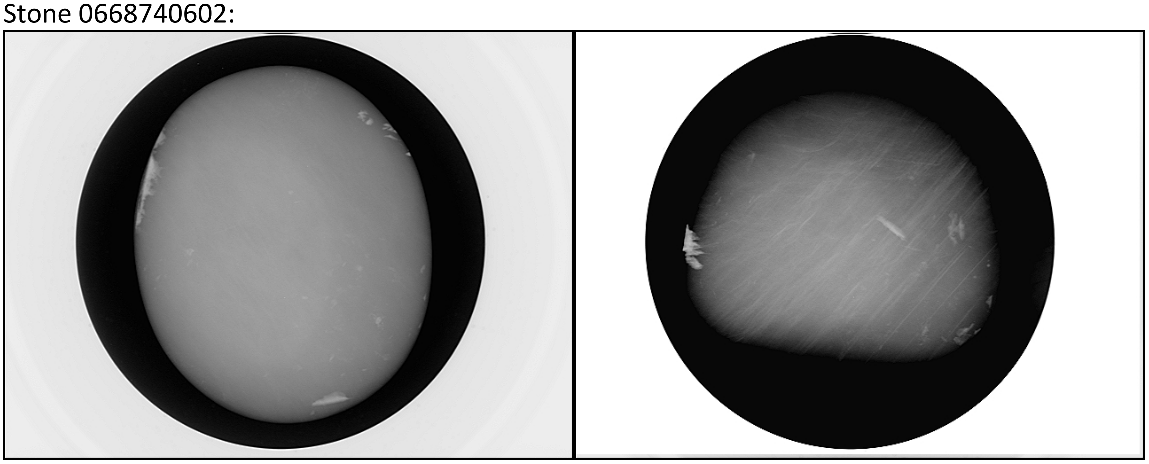

Figure 22: This lead glass filled ruby has several small surface cavities filled with lead glass, due to the thickness of the stone little else can be seen from the top but side-on examination reveals numerous very thin fissures filled with lead glass.

Conclusions and Important Durability Issues:

It was very interesting that a Thai burner contacted laboratory gemologists seeking their assistance in examining his new product and publishing their findings prior to the product's release into the market. Such initiatives and collaborations are very much welcome since they enable people in the market to become aware of new products, understand how to identify them and how to handle them correctly. This is important, since in this case trust in the market should hopefully prevail.

As to the best of our knowledge, the product isn't currently available in the market despite some existing reports on other lead glass filled rubies looking quite similar (GAAJ, 2004, Hainschwang, 2009, Pardieu, 2006), this preliminary study cannot provide information regarding the availability of this new material. Nevertheless it seems that soon large quantities of this material might be available in Thailand.

The reported Madagascar origin of these stones could not be confirmed. Nevertheless the gemological data collected on these stones is very similar to that known for stones from some ruby deposits in East Africa. A visit to the deposit in Madagascar would be necessary to confirm their origin.

The identification of the treatment is not a major technical gemological challenge, at least for knowledgeable gemologists with good instruments. On the other hand in market conditions things might be trickier for people lacking gemological knowledge and training. These stones might therefore be a challenge for the trade, if proper disclosure is not given, particularly because of the durability issues associated with the lead glass filling.

The next step in this study will thus be a more comprehensive study of the material including a specific durability study. The results will be published in an updated version of the present study.

Nevertheless in the case of lead glass filled rubies in general, it is important to keep in mind that the glass used for the process is relatively very soft and has a low melting point. People wearing such stones, and jewelers working with them, should be particularly careful as the glass filled stones can easily be damaged by chemicals (acids, caustic soda, etc...), heat or even scratches and knocks (McClure, 2006).

Thus GIA Laboratory Bangkok gemologists and Mr. Thongdeesuk believe that disclosure about such material at all levels of the supply chain is a vital requirement as it is important for people working with or wearing these treated stones to understand that this material is not as durable and rare as untreated gem material of similar appearance.

For more information on how gemological laboratories like the GIA disclose and describe lead glass filled rubies please consult the LMHC Information Sheet 3 (IS3) included in this study in annex (see Annex A).

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Information Sheet #3
Standardised Gemmological Report Wording

Corundum with glass filled fissures and/or cavities and Corundum-Composite Material

Members of the Laboratory Manual Harmonisation Committee (LMHC) have standardised the nomenclature that they use to describe glass filled fissures and/or cavities in corundum and corundum-composite material. This nomenclature is used for all situations that (i) involve the filling of fissures and/or cavities with glass, where there are indications that the clarity of the corundum has been enhanced/modified by this process with the exception of those covered in Information Sheet #1 and (ii) form a corundum-glass composite material.

Glass filled fissures in corundum:
(see Information Sheet #1 for "healed fissures" and subsequent "residues in fissures")

Any corundum that shows indications of having undergone clarity enhancement/modification usually assisted by heating, through the filling of fissures with glass shall be described as,

- Species: **Natural corundum**
- Variety: **Ruby** or **Sapphire**[3]
- Comments: **(Indications of) Clarity enhancement/modification by a glass filler in fissures** *or* **Glass filled fissures** *or* **Glass in fissures,** plus (the appropriate filler quantification terminology - 'alpha numeric and/or text description' - see table 1), (the identification of the glass material – e.g., lead glass, silica glass, etc.) and/or the statement (introduction of glass into fissures involves heating)[4]
  (This treatment usually applies to low quality stones.)
  (Glass filled corundum is unstable to elevated temperatures and to certain chemical agents.)

Table 1: Quantification table for colourless to near-colourless glass in fissure(s) in corundum

Status:	**No indications of clarity modification**	**Clarity enhancement/modification / glass in fissures**		
Report Alpha numeric:		F1	F2	F3
Report Text:	"No declaration"	*Minor* clarity enhancement/modification by a glass[5] filler in fissures / Glass[3] filled fissures, *Extent: minor*[2]	*Moderate* clarity enhancement/modification by a glass[3] filler in fissures / Glass[3] filled fissures, *Extent: moderate*	*Significant* clarity enhancement/modification by a glass[3] filler in fissures / Glass[3] filled fissures, *Extent: significant*
Further optional report comments:		a lead glass / a silica glass, etc., has been identified as the filler and/or the introduction of glass into fissures involves heating.		

Special Notices
1. Whether using the alpha numeric or text description the report shall also illustrate the equivalent by appending the above chart.
2. The process producing 'glass filled fissures' might also induce healing of fissures and/or fractures (see Information Sheet #1).

[3] 'Sapphire' for the blue variety of corundum. For other colours, 'Sapphire' preceded by its colour (e.g., yellow sapphire, pink sapphire, etc.). See Information Sheet #4 for 'padparadscha sapphire'.
[4] Text in parenthesis is optional.
[5] In case of coloured glass, the report text shall mention the presence of a coloured glass.

Glass filled <u>cavities</u> in corundum:

It is possible that during the glass filling process in addition to fissures, cavities may also become filled with glass. When such glass filled cavities are found in addition to the applicable report text and/or alpha numeric (as above) these shall be described as,

- Comments: **(Indications of) 'Glass filled cavity(ies)** plus (the appropriate filler quantification terminology - 'alpha numeric and/or text description' - see table 2), (the identification of the glass material –
  e.g., lead glass, silica glass, etc.) and/or the statement (introduction of glass into cavities involves heating).
  (This treatment usually applies on low quality stones.)
  (Glass filled corundum is unstable to elevated temperatures and to chemical agents.)

Table 2: Quantification table for colourless to near-colourless glass in cavities in corundum

Status:	**Glass in cavities**		
Report Alpha numeric:	C1	C2	C3
Report text:	"Minor Glass filled cavity(ies)"	"Moderate glass filled cavities"	"Significant glass filled cavities"
Further optional report comments:	a lead glass / a silica glass, etc., has been identified as the filler and/or the introduction of glass into fissures involves heating.		

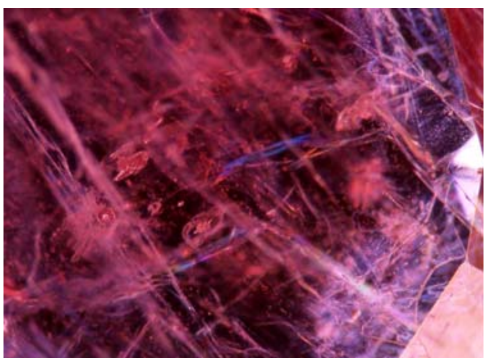


Figure 1a: Colour flashes seen in the area of lead glass filled fractures in ruby

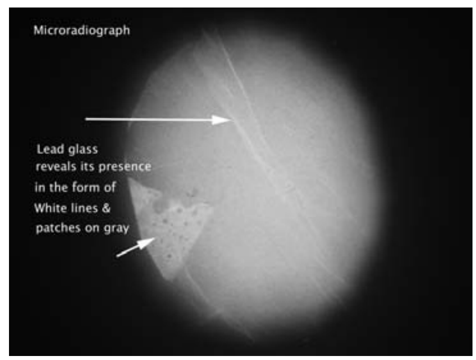


Figure 1b: A microradiograph that reveals the presence of lead glass in fractures

Members of the LMHC determine which quantification terminology to use (see tables 1 and 2) taking into account the size and position of each glass filled fissure and/or cavity. This filling may be of various extents (see examples in figures 2a, b and c.).

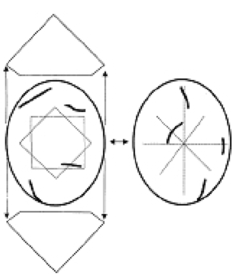


Figure 2a: Glass filled fissures; Extent: minor (F1)

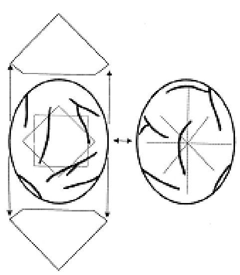


Figure 2b: Glass filled fissures; Extent: moderate (F2)

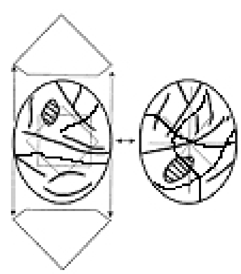


Figure 2c: Glass filled fissures; Extent: significant (F3), and significant glass filled cavities (C3)

Special note:

Durability/stability: Glass filler may be unstable to elevated temperatures and to chemical agents. Special care shall be taken when repairing jewellery items set with glass filled corundum. During jewellery repair the unmounting of such stones is recommended.

Ruby with Glass:

It is possible to assemble and/or to bound several unrelated corundum pieces into one cutting material with glass. When such material is found, it shall be described as,

- species: **'natural corundum with glass'**
- variety: **'ruby with glass'**
- comments: **Fractures filled with glass, which significantly reduces their visibility.** Fracture filling materials such as glass may be unstable to elevated temperature and to chemical agents. (Special care should be taken when cleaning or repairing jewellery items set with fracture filled stones.)

Illustration of the effect of HF acid on corundum with glass:

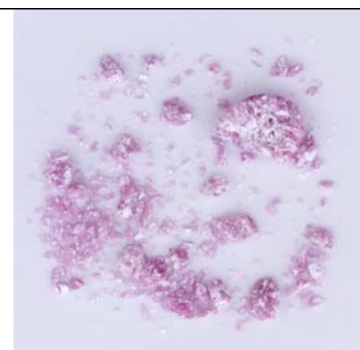
	
Figure 3a: A faceted corundum-glass material	**Figure 3b:** Remaining ruby pieces of the faceted corundum-glass material shown in figure 3a after acid disintegration

Ruby-Glass Composite Material:

It is possible to assemble and/ or to bound a multitude of tiny pieces of ruby into one cutting material with glass. When such material is found, it shall be described as,

- species: **'corundum-glass composite'**
- variety: **'ruby-glass composite', an artificial product**
- comments: **This item is a combination of glass and ruby.** This binding material may be unstable to elevated temperature and to chemical agents. (Special care should be taken when cleaning or repairing composite materials)

Illustration of the effect of HF acid on corundum-glass composite material:

	
Figure 4a: A faceted corundum-glass composite material	**Figure 4b:** Remaining ruby pieces of the faceted corundum-glass composite material shown in figure 4a after acid disintegration (107 hours in HF)