LAB UPDATE
SYNTHETIC RUBY OVERGROWTH ON NATURAL CORUNDUM

By GIT-Gem Testing Laboratory
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INTRODUCTION

The synthetic ruby can be manufactured by many different techniques, such as flame fusion, hydrothermal or flux processes. Because of the low cost and rapid production process, the flame-fusion is, by far, the most common method and still being used for making large color varieties of man-made corundum sold in the marketplace todays. Nonetheless, other types of synthetic ruby are still available in the trade. In other example, flame-fusion seed crystal with synthetic flux overgrowth in a single stone was occasionally appeared in the market and has been reported earlier (Kane, 1985; Gübelin and Koivula, 2005; Sun and Breitzmann, 2014). In early January 2015, the GIT Gem Testing Laboratory (GIT-GTL) encountered one of the unusual synthetic ruby submitted for testing. This stone is somewhat different from the above mentioned synthetics. This article will describe the characteristics of this material.

MATERIALS AND METHODS

The synthetic ruby reported in this study was a 1.84 ct. purplish red faceted stone came in mixed cut and oval shape (Figure1). The stone standard gemological properties were collected using basic gem instruments. The internal features were observed under both (methylene iodide) immersion- and normal-type microscopes and the florescence images by DiamondView. For advanced testing, we used FTIR (model Nicolet 6700), UV-VIS-NIR spectrometer (Model Lambda 950), Raman Spectroscopy (Renishaw, InVia) and EDXRF (model Eagle III) to collect the specific spectroscopic data.

Figure 1: The 1.84 ct. ruby sample submitted for identification. Photo by S. Saengbuangamlam.

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RESULTS

VISUAL APPEARANCE

When viewing face up, the stone appeared purplish red similar to a natural ruby (Figure1).

GENERAL PROPERTIES

The standard gemological properties of the stone were consistent with corundum (see Table 1), for examples, R.I. 1.760-1.769, Birefringence 0.009, S.G. 4.02 and Optic Character as Uniaxial Negative. This stone exhibited strong red fluorescence to long-wave UV radiation, moderate pinkish red to short-wave UV radiation.

MICROSCOPIC FEATURES

This stone, however, showed many unusual internal features under the microscopic observation. As clearly seen under the immersion (Figure 2 left and right), the stone comprised two parts; the core and the thick overgrowth layer. The core occupied majority of the stone and was near-colorless. A part of core was cut-open by the star and bazel facets on one side of the crown. The overgrowth layer was red and rather thick on pavilion side but very thin on the crown side. Under the DiamondView, the cut-open part of the core showed no fluorescence while the overgrowth layer gave intense even red fluorescence (Figure 3). This strong contrasting fluorescence behavior could reflect the differing trace element constituents between the overgrowth layer and the core material.

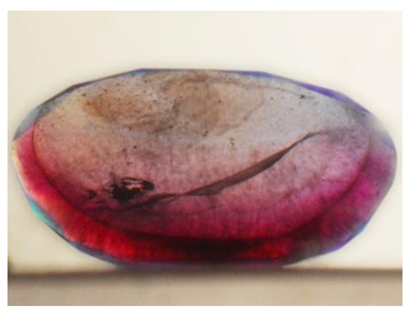

Figure 2: Immersion images showing clearly the near-colorless core occupying majority of the stone and the thick red color overgrowth layer on the pavilion side (left photo, side view of the stone table-facet-down position; right photo, side view of the stone tilted-table-facet-up position; Immersion in di-iodomethane or methylene iodide solution under diffuse light-field illumination, magnified 20X). Photo by S. Saengbuangamlam.

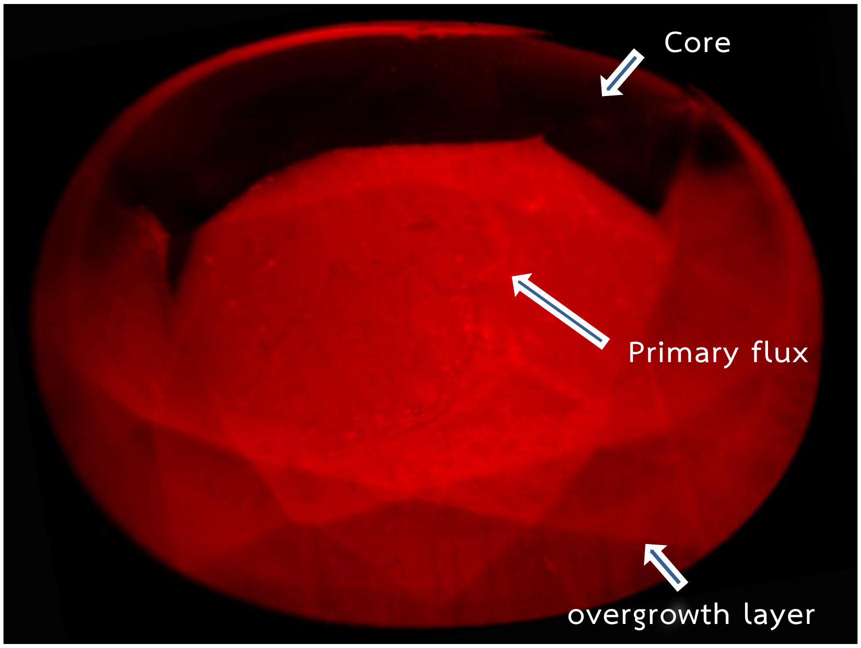

Figure 3: DiamondView image of the face-up stone showing the non-fluorescence core part that was cut-open by the star and bazel facets above (dark area pointed by the top arrow) in contrast to the intense even red fluorescence overgrowth layer on the table, star and bazel facets below (bottom arrow). Note also the bright red fluorescence of the flux fingerprint inclusions on the table facet. Photo by S. Promwongnan.

Close examination with both types of microscopes revealed that the overgrowth layer showed many tiny wispy veil-like fingerprints typical of synthetic flux-grown ruby (Figure 4 left and center). The roiled effect due to the irregular growth structure was also observed near the boundary between the overgrowth layer and the core (Figure 4 right). The core area, on the contrary, contained many large planar fingerprints, two-phases fluid inclusions appeared as drip-like trails and melted crystals indicating a heat-treated natural ruby (Figure 5). Such contrasting evidences pointed to a conclusion that this stone was a flux-grown synthetic ruby overgrowth on a natural sapphire seed crystal.

Figure 4: The thick red overgrowth layer is clearly seen on the pavilion side of the stone (left, magnified 16X). Higher magnification of the overgrowth layer revealed numerous fine wispy veil-like flux inclusions (center, magnified 25X) and

roiled effect due to the irregular growth structure near the boundary between the overgrowth layer and the core (right, magnified 25X). Photomicrograph by S. Promwongnan.

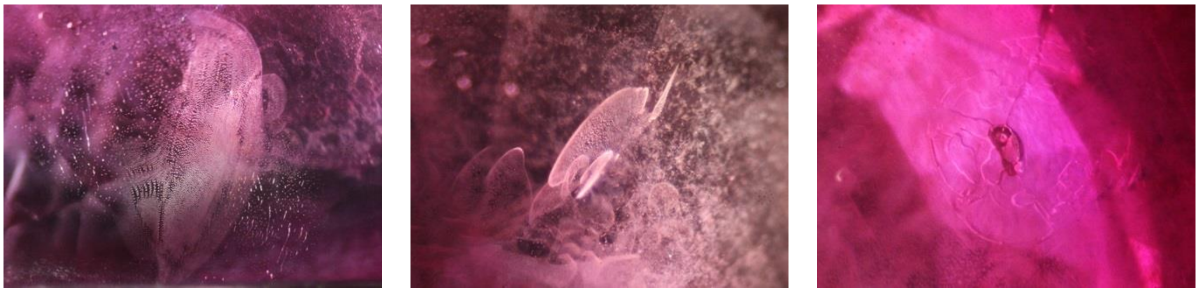

Figure 5: Magnification of the core area of this stone showing many natural planer fingerprints (left and center, magnified 20X) and a melted inclusion indicating its natural origin (right, magnified 25X). Photomicrograph by S. Promwongnan.

Table 1. Properties of Synthetic ruby overgrowth on natural corundum

Property	Values and Description
Refractive Index	1.762–1.770 (0.008)
Polariscope Reaction	Double Refractive, Uniaxial
Specific Gravity (Hydrostatic)	4.02
UV Fluorescence	LW: strong red, SW: moderate pinkish red
DiamondView	**Synthetic overgrowth layer**: intense even red fluorescence **Natural seed crystal:** non-fluorescence
Pleochroism	Purplish red/orangy red
Inclusions	**Synthetic overgrowth layer**: Primary flux inclusions and numerous wispy veil-like fingerprints, roiled effect from irregular growth structure **Natural seed crystal**: Large planar fingerprints, two-phases fluid inclusions and melted crystals

ADVANCED TESTING

To further prove this assumption, advanced testing was further carried out.

Spectra

The IR spectra gave the absorption spectrum commonly of corundum. The UV-Vis absorption spectra showed absorption bands due to Cr^{3+} as typical color-causing element in ruby. Raman analysis also confirmed that both synthetic overgrowth and natural core parts of this material were corundum.

Chemistry

Trace element contents obtained by EDXRF (see Table 2) gave very low Fe and Ga but high Cr on the overgrowth layer of pavilion side. In contrast, the core part of the stone cut-open by the star and basel facets gave significant contents of Cr, Fe and Ga. This result is consistent with the chemical element differences between the synthetic flux-grown ruby and the natural sapphire in general.

Table 2: Trace element contents of the core and overgrowth layer of the stone obtained by EDXRF

Element (Oxides wt.%)	TiO_2	V_2O_5	Cr_2O_3	Fe_2O_3	Ga_2O_3
The overgrowth layer on pavilion	0.0042	0.0052	0.6540	0.0043	BDL
The exposed core area	0.0137	0.0033	0.0743	0.0777	0.0123

CONCLUDING REMARKS

Based on the aforementioned data, it can be concluded that this stone is a synthetic ruby overgrowth on a natural corundum seed crystal. In fact, this synthetic product is not new but has been circulated in the market in early 2000s (Smith, 2002). At that time this product was sold under the name “Diffusion ruby”, but later most of these gem materials were proved to be synthetic ruby overgrowth on natural sapphire rather than diffusion of chromium into the crystal lattice of corundum. This synthetic product was faded out from the market for decade. However, the product could re-emerge in the market anytime. Therefore, careful microscopic examination of the stone is necessary to clearly distinguish this type of synthetic stone from the natural one, such as the distinctive inclusions and strong contrasting fluorescence behavior under DiamondView between the synthetic overgrowth layer and the natural seed crystal.

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