Synthetic ruby overgrowth on natural corundum

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Introduction

A flame-fusion seed crystal with synthetic flux overgrowth in a single stone occasionally appeared in the market (Kane, 1985; Gübelin and Koivula, 2005; Sun and Breitzmann, 2014). In early January 2015, an unusual synthetic ruby was encountered by GIT Gem Testing Lab. (Figure 1). This stone is somewhat different from the above mentioned synthetics and will be described hereafter.

Figure 1. *The 1.84-ct. faceted cut ruby used in this study. Photo. by S. Saengbuangamlam*

General Properties

The sample used in this study was a 1.84 ct. faceted (oval, mixed cut) ruby (Figure 1). In the face-up position, the stone appears purplish red similar to a natural ruby. The stone's standard gemological properties are consistent with those of ruby (see Table 1).

Table 1. *Gemmological properties of synthetic ruby overgrowth on natural corundum*

Property	*Values and Description*
Refractive Index	1.762–1.770 (0.008); Uniaxial Negative
Polariscope Reaction	Doubly Refractive
Specific Gravity (Hydrostatic)	4.02
Pleochroism	Purplish red / orangy red
UV Fluorescence	LW: strong red, SW: moderate pinkish red

Microscopic Features

Microscopic examination can disclose many unusual internal features. The stone comprises two parts, a thick,strong red, overgrowth layer and a paler colored core (Figure 2 left). The overgrowth layer shows many tiny, wispy veil-like fingerprints, typical of synthetic flux-grown ruby (Figure 2 center). A roiled effect, due to an irregular growth structure is also present near the boundary between the overgrowth layer and the core (Figure 2 right).

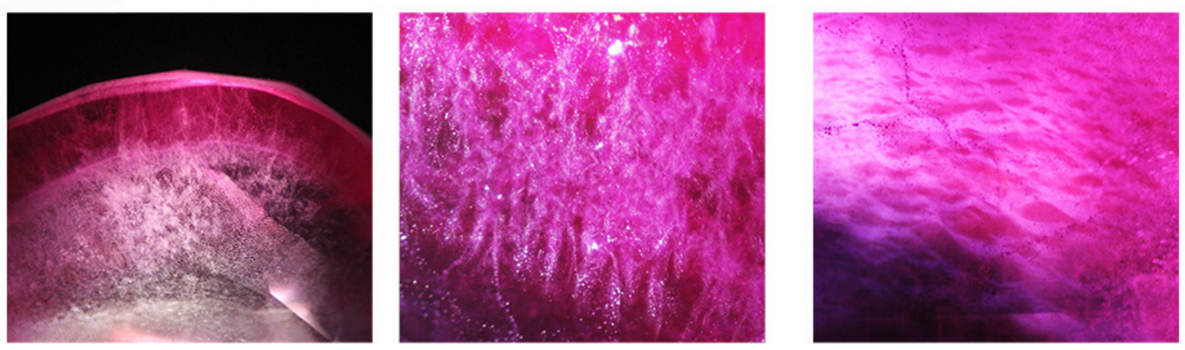

Figure 2. *The thick red overgrowth layer clearly seen on the table side of the stone (left, magnified 16X). Higher magnification of the overgrowth layer reveals numerous fine wispy veil-like flux inclusions (center, magnified 25X) and a roiled effect due to the irregular growth structure near the boundary between the overgrowth layer and the core (right, magnified 25X). Photomicrographs by S. Promwongnan.*

The core area, on the contrary, contains many large planar fingerprints (Figure 3 left and center), two-phase fluid inclusions that appeared as drip-like trails and melted crystals, indicating a heat-treated natural sapphire (Figure 3 right). These pieces of contrasting evidence lead to the conclusion that this stone is a flux-grown synthetic ruby overgrowth on a natural sapphire seed crystal.

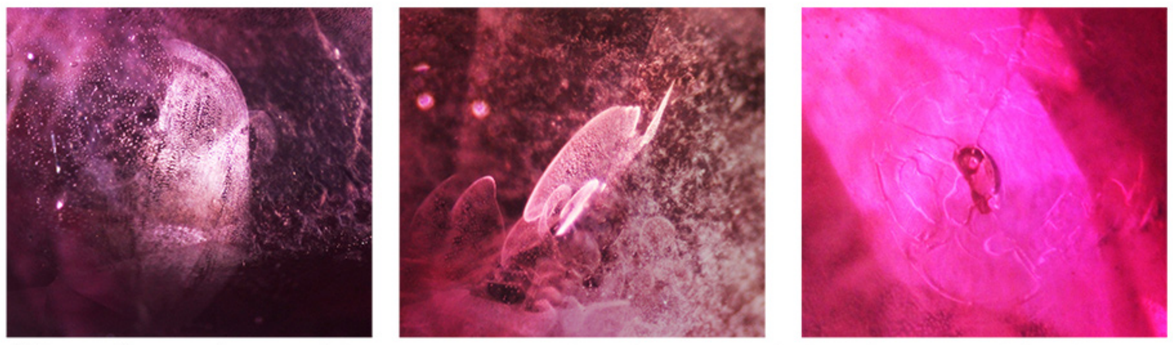

Figure 3. *Magnification of the stone's core area showed many natural planar fingerprints (left and center, magnified 20X) and a melted inclusion indicating its natural origin (right, magnified 25X). Photomicrographs by S. Promwongnan.*

Under an immersion microscope, using low magnification, the complete overgrowth layer all along the core of the stone, appeared as a sharp contact boundary (Figure 4 left). The core occupies a major part of the stone and is near-colorless (Figure 4 right). The overgrowth layer is strong red and rather thick on the pavilion side but very thin on the crown side.

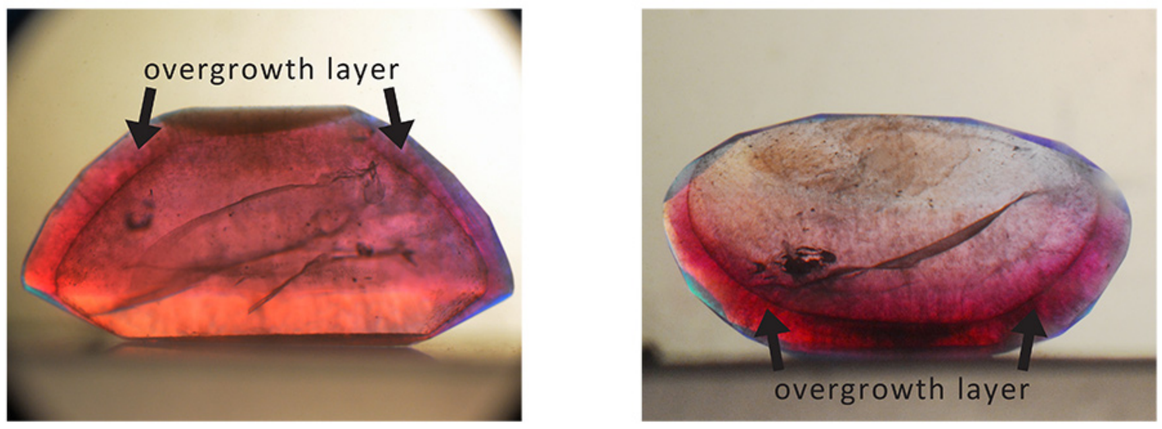

Figure 4. *Immersion images clearly showed the near-colorless core occupying a major part of the stone and the thick red color overgrowth layer on the pavilion side (left: side view of the stone, table-down position; right: side view of the stone, tilted-table-facet-up position; immersion in methylene iodide solution under diffuse light - field illumination). Photo by S. Saengbuangamlam.*

Fluorescence images obtained by the DiamondView are also very useful for identification. The image shows a part of the core that reached the surface at the star and bezel facets on one side of the crown (Figure 5). The part that reached the surface was inert to the UV radiation while the overgrowth layer showed an intense, even red fluorescence. Such strong contrasting fluorescence reaction is due to the difference of trace element constituents between the overgrowth layer and the core material (see Table 2). The flux fingerprint inclusions on the table facet also appeared as bright red fluorescence patches on the DiamondView image (Figure 5).

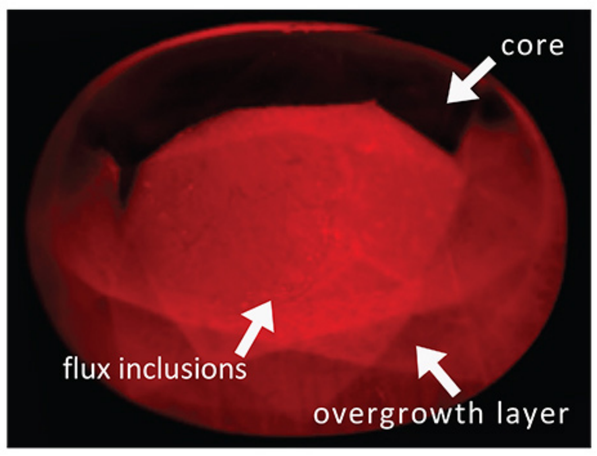

Figure 5. *DiamondView image of the stone (face-up) showing the non - fluorescence core reaching the surface at the star and bezel facets above (dark area) in contrast to the intense even red fluorescence overgrowth layer on the table, star and bezel facets below. Note also the bright red fluorescence patches of flux fingerprint inclusions on the table facet. Photo by S. Promwongnan.*

Chemical Analysis

Semi-quantitative chemical analysis (see Table 2) indicates very low contents of Fe, Ti and Ga but rather high Cr on the overgrowth layer of pavilion side. On the contrary, the core part of the stone reaching the surface at the star and bezel facets gives relatively higher contents of Fe, Ti and Ga but rather low Cr. Such contrasting results again are consistent with chemical elements commonly found in synthetic flux-grown ruby and natural sapphire, respectively.

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 the pavilion	<0.01	0.01	0.65	<0.01	<0.01
The exposed core area	0.01	<0.01	0.07	0.08	0.01

Conclusion

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 since the 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 a 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 a natural ruby. Distinctive inclusions are the sharp contact boundary under immersion and the strong contrasting fluorescence behavior under the DiamondView, between the synthetic overgrowth layer and the natural seed crystal.

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