

# SOME TANZANITE IMITATIONS

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*Since at least 1995, various materials have been manufactured to imitate tanzanite in the gem trade. These include two glasses, two different YAGs (yttrium aluminum garnet), and a synthetic corundum. These imitation tanzanites can be readily separated from the natural gem by standard gemological tests, such as refractive indices, optical character, specific gravity, UV-visible spectra, fluorescence, and the presence or absence of pleochroism. The identifications were confirmed by chemical analysis and Raman spectroscopy.*

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Tanzanite, the blue-to-violet gem variety of zoisite, was first discovered in Tanzania in the 1960s (see, e.g., Bank et al., 1967). It has increasingly gained popularity as a result of its unusual color and the attractiveness of the cut stones. Most of the material that enters the gem trade is actually brown zoisite that has been heat treated to blue to violet (Nassau, 1994). Although a number of gem materials, including spinel and iolite, may resemble tanzanite, manufactured imitations of this material have also started to appear on the market (figure 1). These recent tanzanite imitations were mentioned by Kammerling et al. (1995) and in the ICA Gazette ("Gem news," 1996). Johnson and Koivula (1996) describe one of the imitations in more detail. However, rumors of Russian imi-

tations, and of efforts by Russian manufacturers to produce synthetic tanzanite, were mentioned as early as 1991 (Koivula and Kammerling, 1991).

The present article characterizes and provides identification criteria for some of the imitations that have recently appeared on the market, including: (1) a doped heavy glass marketed under the trade name U.M. Tanzanic and produced by U.M. Science Company, Glendale, California; (2) a YAG (yttrium aluminum garnet, a manufactured material) from Lannyte Company, Houston, Texas, which has been sold under the trade name Purple Coranite (figure 2); and (3) a synthetic corundum, also from Lannyte, marketed as Blue Coranite (figure 1). Also included are another glass and another YAG, with slightly different properties, that could be mistaken for tanzanite without gemological testing.

For the gemologist, these materials are easy to distinguish from tanzanite (see Box A) on the basis of specific gravity, refractive indices, optic character, internal features, and—to a lesser extent—their spectroscopic characteristics. To characterize these simulants fully, they were also analyzed chemically and by Raman spectroscopy.

## CHARACTERISTICS OF THE TANZANITE IMITATIONS

**Materials and Methods.** The three imitations noted above—U.M. Tanzanic, Blue Coranite, and Purple Coranite—were readily available at the February 1996 Tucson gem shows. The authors purchased

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five faceted samples (0.59–2.89 ct) of the heavy glass (U.M. Tanzanic) and one 1.64 ct faceted synthetic corundum (Blue Coranite) for investigation purposes. In addition, the Lannyte Company kindly supplied us with one rough (112.54 ct) and one 0.72 ct faceted piece of their YAG (Purple Coranite).

We also included in our study a 1.99 ct blue YAG from Russia and a 6.90 ct bluish purple Ca-phosphate glass [again, see figure 1]. Although these two samples do differ somewhat in color from tanzanite, they are sufficiently close to be mistaken for it.

We determined refractive index, optic character, and specific gravity using standard gemological instrumentation and techniques. S.G. was determined hydrostatically; the values reported are the average of at least two measurements per sample. Microscopic investigations were carried out with darkfield illumination in air with a Gemolite binocular microscope, as well as with immersion in methylene iodide using a Nacet horizontal microscope. We tested the fluorescence to short- and long-wave UV radiation using a commercial gemological UV lamp, and we tested spectroscopic properties with a laboratory spectroscope (both instruments by System Eickhorst).

Semi-quantitative chemical analyses of all samples were performed by energy-dispersive X-ray fluorescence (EDXRF) spectroscopy on a Tracor Northern TN 5000 system. In addition, quantitative chemical data for samples of the heavy glass (U.M. Tanzanic) and the synthetic corundum (Blue Coranite) were obtained using a JEOL 8600 electron microprobe. Raman spectroscopy was carried out on all samples with a Renishaw Raman System 1000 with a 25 mW air-cooled Argon Ion Laser (Omnichrome) lasing at 514 nm. Analysis times were between 60 and 100 seconds, depending on peak intensities and background fluorescence; the spectral range covered was between 100 and 1900  $\text{cm}^{-1}$  (see also Hanni et al., 1996).

**U.M. Tanzanic.** In their advertising brochure for this material, U.M. Science Co. claims that it was created by means of a high-temperature flux process. The material is described as a mix of amorphous and microcrystalline phases, with a refractive index of 1.66–1.67 and a specific gravity of 3.8–4.0. The brochure also lists a number of other properties, such as the absence of internal stress.

**Gemological Properties.** Our results for the five faceted samples that we tested did not correspond to those published by the producer. The refractive indices varied between 1.600 and 1.605 (isotropic).



Figure 1. Several manufactured materials have appeared on the gem market as tanzanite imitations. A number of these are shown here together with two natural tanzanites. From left to right: (top row) two tanzanites (3.03 ct and 5.89 ct) and a 6.90 ct sample of Ca-phosphate glass; (bottom row) a 1.64 ct synthetic corundum (called Blue Coranite), a 1.99 ct synthetic garnet from Russia, and two samples (2.89 ct and 0.92 ct) of heavy glass (U.M. Tanzanic). Photo by H. A. Hänni.

The specific gravity ranged from 3.36 to 3.48. All specimens showed a poorly polished surface. Three of the five samples were virtually free of any internal features, but two showed diffuse, syrup-like flow structures. One of these two samples also had an irregularly shaped milky white inclusion, probably a microcrystalline portion of the surrounding glass, with syrup-like flow structures (figure 3). The samples fluoresced chalky white to both short- and long-wave UV. They showed weak absorption bands at approximately 490, 550, and 590 nm.

**Chemical Composition.** We recorded an inhomogeneity in chemical composition among the five samples (see table 1), as well as within the samples. PbO contents between 38.5 and 51.2 wt.% were measured, which appear to be extremely high. The products of other heavy-glass manufacturers only go up to 30 wt.% PbO (Swarogem, pers. comm., 1996). Perhaps U.M. Science Co. uses a light element such as B or Li in their glasses, neither of which is detectable using the microprobe or X-ray fluorescence units available to the authors.  $\text{SiO}_2$  contents varied between 46.3 and 58.3 wt.%. The  $\text{K}_2\text{O}$  content ranged between 2.3 and 3.2 wt.%, and the trace elements Mn and Fe were 0.08–0.14 wt.% and 0.03–0.07 wt.%, respectively, expressed as oxides (see table 1). For the two major elements, Si and Pb,  $\text{SiO}_2$  and PbO concentrations within one



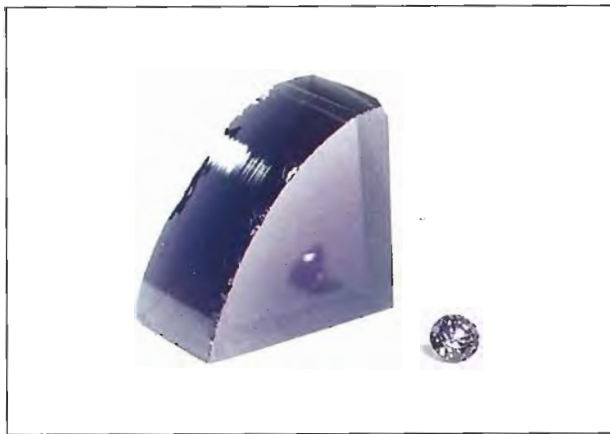


Figure 2. Purple Coranite is a YAG manufactured by the Czochralski method that is marketed as a tanzanite imitation. The unfaçoned section weighs 112.54 ct; the faceted piece is 0.72 ct. Photo by H. A. Hänni.

stone varied by up to 7 wt.% (see table 1). Al<sub>2</sub>O<sub>3</sub> levels were below the detection limits of the EDXRF apparatus and the microprobe.

The Raman spectra of this material showed broad peaks at Raman shifts of 505, 777, 989, and 1064 cm<sup>-1</sup> (figure 4), as well as a considerable fluorescence to Argon laser light at 514 nm, as can often be observed in glass (Chemarin et al., 1996; Sharma and Wang, 1996).

**Coranite.** The Lannyte Company offered two tanzanite imitations: a YAG marketed as Purple Coranite and a synthetic corundum sold as Blue Coranite. The manufacturer reported that both materials are grown using the Czochralski-pulling method.

*Purple Coranite.* The manufacturer's brochure reported that "the material is garnet based, with a hardness of nearly 9 and a refractive index of over 1.80. Our investigations confirmed that the R.I. is over 1.80, and we measured a specific gravity of 4.58,

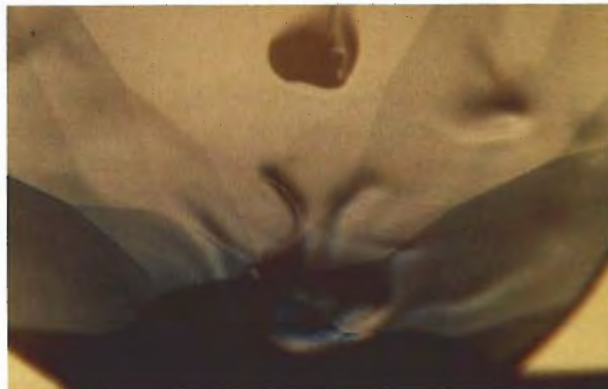


Figure 3. Solid inclusions and a syrup-like flow structure are evident in this heavy glass manufactured as a tanzanite imitation by U.M. Science Co. Immersion, magnified 35x.

which is slightly higher than published data for YAG (e.g., Nassau, 1980). We saw no pleochroism in the samples, but we did see some strain with the polariscope. Spectroscopic observation showed a broad band at approximately 540 nm.

The material fluoresced a strong chalky orange to short-wave UV radiation (figure 5). Similar data were obtained by Johnson and Koivula (1996) on a 7.07 ct tanzanite imitation purchased in 1995. EDXRF analysis of their specimen revealed yttrium, aluminum, and europium; all three elements were found in the EDXRF analyses of our two purple coranite samples.

The piece of unfaçeted Purple Coranite was polished on one side for microscopic examination. However, we saw no bubbles or other internal features. Color zoning was apparent with the unaided eye: The core was a distinctly darker purple than the rim, and the color faded gradually from core to rim. The orange fluorescence corresponded to the zoning, but inversely; that is, it was brightest near the colorless rim (figure 5). Microscopic examination of the small faceted sample showed no growth

TABLE 1. Chemical composition of five glass imitations of tanzanite from U.M. Science Co.

Oxide (wt.%)	Sample 1 <sup>a</sup> (2.89 ct)	Sample 2 <sup>b</sup> (1.84 ct)	Sample 3 <sup>a</sup> (0.92 ct)	Sample 4 <sup>a</sup> (0.76 ct)	Sample 5 <sup>b</sup> (0.59 ct)
SiO <sub>2</sub>	51.26–58.30	51.39–55.77	50.25–55.50	46.32–51.55	46.49–50.13
K <sub>2</sub> O	2.87– 3.09	2.66– 3.15	2.89– 2.94	2.29– 2.84	2.29– 2.62
MnO	0.09– 0.10	0.08– 0.09	0.11– 0.13	0.11– 0.13	0.10– 0.14
FeO	0.04 ± 0.002	0.03– 0.04	0.05 ± 0.002	0.05– 0.07	0.04– 0.05
PbO	38.47–45.53	40.96–45.68	41.39–46.69	45.50–51.20	47.17–51.06

<sup>a</sup> Range of 3 microprobe analyses. <sup>b</sup> Range of 4 microprobe analyses.

## BOX A: CHARACTERISTICS OF TANZANITE, THE BLUE-TO-VIOLET VARIETY OF ZOIISITE

Zoisite is an orthorhombic silicate mineral of the epidote group with the chemical formula:  $\text{Ca}_2\text{Al}_3\text{Si}_3\text{O}_{12}(\text{OH})$ . Crystalline zoisite is found in various hues, including colorless, brown, yellow, blue, purple, green, and pink. Certain ornamental rocks, such as anyolite and saussurite, contain massive zoisite (Webster, 1975). The best known zoisite is the transparent blue-to-violet variety, tanzanite, a name first promoted by Tiffany and Company in the late 1960s.

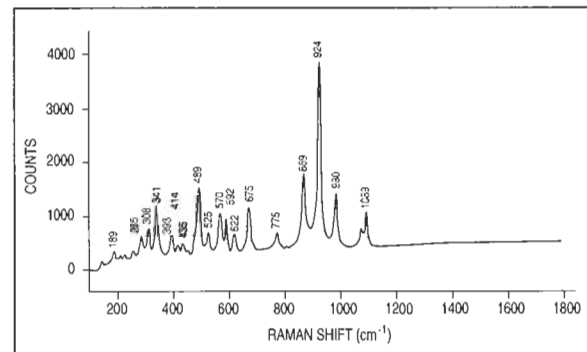
The specific gravity of tanzanite is 3.35, with a hardness of 6–7 and refractive indices of  $n_\alpha = 1.692$ ,  $n_\beta = 1.693$ , and  $n_\gamma = 1.700$ , with a birefringence of 0.008 (Webster, 1975). There is one perfect cleavage. Tanzanite typically exhibits trichroism of  $a$  = violet blue,  $b$  = violet, and  $c$  = brownish red, and it shows broad absorption bands at approximately 535 and 595 nm in the spectroscope (Gem Reference Guide, 1995). Tanzanite is inert to ultraviolet radiation (see, e.g., Malisa et al., 1986; Barot and Boehm, 1992).

**Inclusions.** A variety of inclusions have been identified in tanzanite: calcite, gypsum, graphite, hematite, ilmenite, staurolite, rutile, titanite, xenotime, quartz, diopside and tremolite-actinolite, as well as fluid inclusions in healed "feathers" (Gübelin and Koivula, 1986; Malisa et al., 1986). As noted by Barot and Boehm (1992), however, faceted tanzanites are often flawless, because most inclusions are removed in the cutting process.

**Chemical Composition.** In 1967, Bank et al. reported on strontium-containing blue zoisite crystals. In 1969, Hurlbut described this Tanzanian material more comprehensively, published a chemical analysis, and attributed the blue color to its vanadium content: 0.03–0.44 wt. %  $\text{V}_2\text{O}_5$ . For more information about trace elements in tanzanite, refer to Schmetzer (1978, 1982), Barot and Boehm (1992), and Traber (1995).

Tanzanite also has a characteristic Raman spectrum (figure A-1), so that it can be easily separated from simulants or imitations by Raman spectroscopy alone.

Figure A-1. This Raman spectrum of a tanzanite crystal loaned by Th. Ostertag, Freiburg, Germany, is consistent with the Raman spectra of other tanzanites seen in the SSEF laboratory.



structures, but it did reveal small bubbles that were arranged in a circular pattern.

The Raman spectra of the two Purple Coranite samples that we examined were very distinct, with a large number of peaks; some of these were at positions different from those in the Raman spectra of the other YAG investigated and described below (figure 6). Additional Raman studies of various colors of YAG showed that their peak intensities, and some peak positions, vary depending on the doping element. The Raman spectrum of a colorless YAG reproduced in Pinet et al. (1992) corresponds to that of the colorless YAG we analyzed.

**Blue Coranite.** The gemological properties of this synthetic corundum are consistent with the known properties for corundum and are similar to those reported by Kammerling et al. (1995) for comparable material. The 1.64 ct oval cut that we examined had a specific gravity of  $4.02 \pm 0.02$  and refractive

indices of  $n_e = 1.764$ ,  $n_o = 1.771$ , with a birefringence of 0.007. In contrast to tanzanite, corundum is uniaxial, and this material showed much weaker pleochroism from purplish blue (ordinary ray) to light grayish blue (extraordinary ray). No lines were observed in the spectroscope. The sample was inert to both short- and long-wave UV radiation. Microscopic examination revealed no inclusions or growth features.

The chemical composition of this sample of Blue Coranite is similar to that of synthetic sapphire, with few trace elements and no V or Ga. The only elements we detected were Al (in a major amount) and Ti and Fe (each in the same amount, as trace elements). The  $\text{TiO}_2$  content varied slightly within the sample. The Raman spectrum of our sample of Blue Coranite corresponds to the Raman spectra of other corundum samples, with only weak peaks at 375, 416, 577, 644 and  $750 \text{ cm}^{-1}$  (see Pinet et al., 1992).

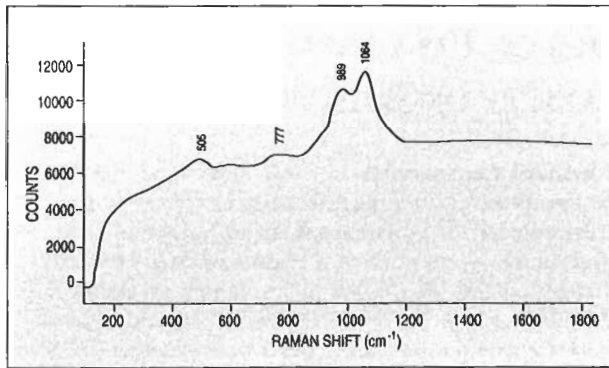


Figure 4. This Raman spectrum of the heavy-glass imitation of tanzanite illustrated in figure 3 shows broad peaks at Raman shifts of 505, 777, 989, and 1064  $\text{cm}^{-1}$ .

**YAG from Russia.** A 1.99 ct round-brilliant-cut synthetic garnet from Russia (again, see figure 1) was available from the collection of Dr. H. A. Hänni, SSEF Swiss Gemmological Institute, who purchased it in 1991 from Mr. P. Hollenstein of Zurich, Switzerland. It had an S.G. of 4.56 and an R.I. over 1.80. As with the Purple Coranite, this sample showed no pleochroism, but we observed some strain with the polariscope. Also, it fluoresced a moderate orange to short-wave UV radiation. We also saw minute inclusions on an irregular plane throughout the piece. They resembled the rutile particles frequently observed in corundum.

The chemical composition of this synthetic was found to be mainly Y and Al, with traces of Yb. The Raman spectrum differed distinctly from the one

Figure 5. This sample of Purple Coranite, a YAG manufactured to imitate tanzanite, fluoresced a strong, chalky orange to short-wave UV radiation. Note that the fluorescence is strongest near the near-colorless rim. Photo by L. Kiefert.

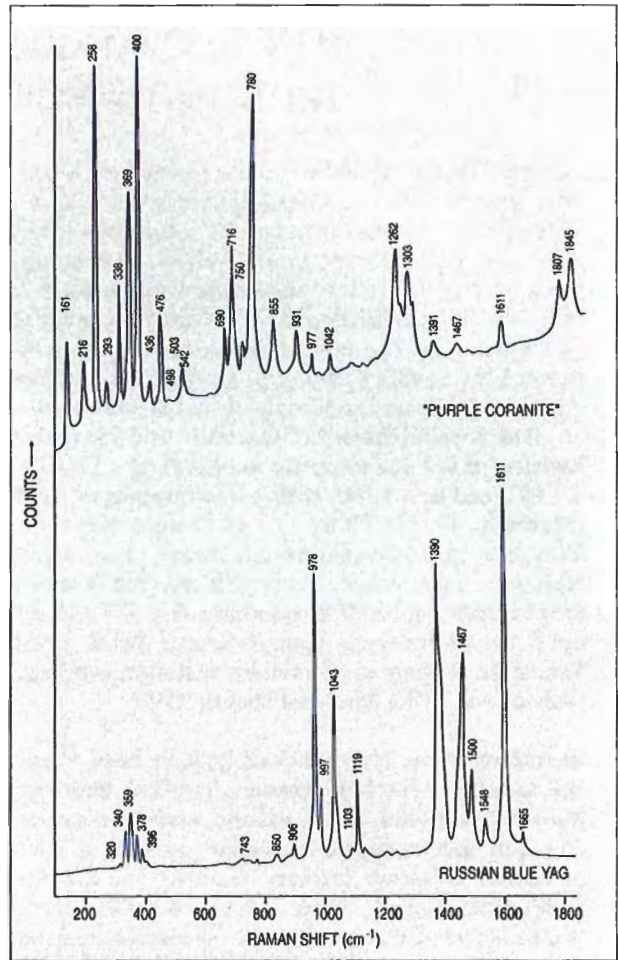


Figure 6. The Raman spectra of these two YAGs manufactured by the Lannyte Co. (top) and in Russia (bottom) differ from each other because of different trace elements, but neither resembles the spectrum of tanzanite.

obtained for Purple Coranite because of the different trace elements (again, see figure 6). We observed no characteristic spectrum in the spectroscope.

**Ca-phosphate Glass.** The mineral display at the University of Nantes contains a 6.90 ct bluish purple brilliant-cut that was described to one of the authors by Dr. E. Fritsch, Nantes, as synthetic Ca-phosphate glass (again, see figure 1). It had been purchased several years earlier at a Tucson Gem Show. Testing revealed a refractive index of 1.537 for this isotropic material, a specific gravity of 2.64, and no reaction to either long- or short-wave ultraviolet radiation. In the spectroscope, we observed a moderate band in the yellow at 580 nm.

When viewed with the microscope, the piece revealed the irregular flow structures and large number of bubbles frequently observed in glass (fig-





Figure 7. Bubbles and devitrification crystals help identify this sample as a purple Ca-phosphate glass. Immersion, magnified 35 $\times$ .

ures 7 and 8). Raman spectra of the bubbles gave no specific peaks, which suggested that they might contain air. We observed devitrification effects around some of the bubbles, which had the appearance of needle-like crystals forming a radial pattern (figure 8). Various crystalline phases, such as that illustrated in figure 9, and an apparently orthorhombic crystal inclusion were also seen.

This sample was very similar in chemistry to apatite, with high amounts of Ca and P. We also recorded minor amounts of Mg, K, Fe, Co, Sr, and Zr, as well as traces of Zn.

The Raman spectrum showed a curve similar to that of other amorphous materials, with broad peaks (figure 10). The spectrum of the needle-like inclusions, however, had much more discrete peaks, at the same position as the broad peaks from the larger sample; whereas the orthorhombic crystal revealed peaks that were not observed in either the host or the crystallized areas around the bub-

Figure 9. Various crystal phases were seen in this Ca-phosphate glass. Magnified 100 $\times$ .

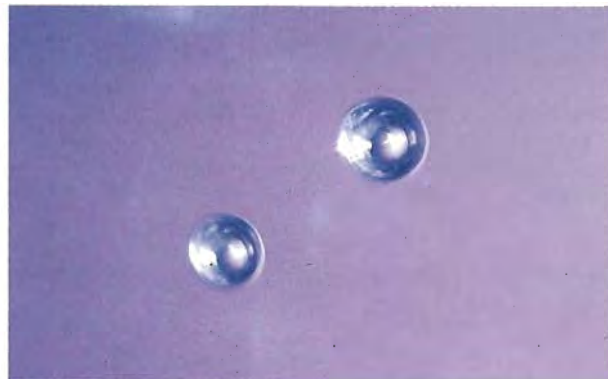
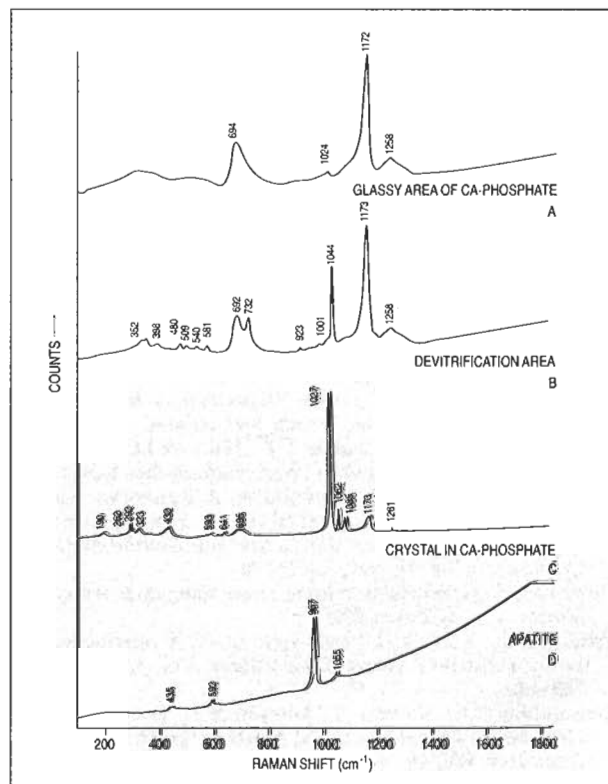


Figure 8. Bubbles help show that this is a Ca-phosphate glass. Note also the needle-like devitrification features on the large bubble. Magnified 100 $\times$ .

bles. The Raman spectrum of apatite, however, is distinctly different (again, see figure 10).

The measured properties of this unusual stone contain no conclusive evidence as to the nature of the material, other than the fact that it is a Ca-phosphate glass.

Figure 10. Raman spectra of a purple Ca-phosphate with glass structure (A), devitrification area (B), and crystal inclusions (C) help characterize this tanzanite imitation, which was chemically similar to apatite (D).



**TABLE 2.** Gemological properties of tanzanite and some imitations.

Trade name	Identification	Number of samples	Refractive index	Birefringence	Specific gravity	UV fluorescence	
						Short-wave	Long-wave
Tanzanite	Zoisite	NA <sup>a</sup>	1.688–1.696 to 1.691–1.700	0.008 – 0.009	3.35	None	None
U.M. Tanzanic	Heavy Pb-glass	5	1.600–1.605	Isotropic	3.36 – 3.48	Chalky white	Chalky white
Purple Coranite	YAG	2	> 1.80	Isotropic	4.58	Strong chalky orange	Weak, chalky orange
Blue Coranite	Synthetic corundum	1	1.764( $n_g$ )–1.771( $n_o$ )	0.007	4.02	None	None
Russian YAG	YAG	1	> 1.80	Isotropic	4.56	Moderate orange	None
None	Ca-phosphate glass	1	1.537	Isotropic	2.64	None	None

<sup>a</sup> Not applicable; properties quoted for tanzanite are from literature sources referenced in the text.

## DISCUSSION AND CONCLUSIONS

Various tanzanite imitations are gradually entering the gem market. Three of the most convincing in appearance are the heavy glass manufactured by U.M. Science Co. and marketed under the name U.M. Tanzanic, the YAG manufactured by the Lannyte Company (and marketed as Purple Coranite), and the synthetic corundum by Lannyte that is sold as Blue Coranite. For the gemologist, tanzanite imitations are easily detectable because of differences in

refractive index and specific gravity (table 2). Pleochroism and optic character are also helpful, as tanzanite has a relatively strong pleochroism compared to the only other pleochroic imitation, Blue Coranite. However, Blue Coranite is uniaxial, whereas Tanzanite is biaxial. The tanzanite imitations can also be identified with a handheld spectroscope, provided good spectra are obtained. Chemical composition and Raman spectra are useful to confirm that these are indeed imitations.

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