Synthetic Cubic Stabilized Zirconia

A New Effective Diamond Substitute

By RICHARD T. LIDDICOAT, JR. and JOHN I. KOIVULA
with photographs by Michael D. Waitzman and Michael R. Havstad

A Brief Description

Synthetic cubic stabilized zirconia, a newcomer in gemology, can now be added to the growing list of diamond substitutes. It is perhaps the most satisfactory of the one-piece diamond substitutes to date. As the name implies, cubic zirconia crystallizes in the cubic (isometric) crystal system. The chemical formula is ZrO_2 with minor amounts of certain metallic oxides like calcium oxide (CaO) or yttrium oxide (Y_2O_3) that act as structure stabilizing agents in the otherwise naturally monoclinic material.

The refractive index of cubic zirconia varies between 2.15 and 2.18 which is somewhat less than diamond's fairly constant 2.42 reading. The slightly lower refractive index is, in general, balanced out by a dispersion of approximately 0.060 which is greater than diamond's dispersion of 0.044. Showing no cleavage and with a hardness of 7-1/2 to 8-1/2 on the Mohs scale, cubic zirconia is a very acceptable synthetic gem material.

The much higher specific gravity of cubic zirconia, 5.60 to 5.95, compared to diamond's 3.52, makes this property a good test for gemological separation if the stone is unmounted. Under magnification, due to cubic zirconia's much lower hardness, rounded facet junctions and polishing lines will often be noted. In addition, cubic zirconia may contain small negative crystals arranged in sub-parallel rows that appear as tiny bubbles of very high relief. The negative crystals may in turn be lined or partially lined with a white powder that is probably undigested ZrO_2. On rare occasions negative crystals may be somewhat larger and more easily resolved.

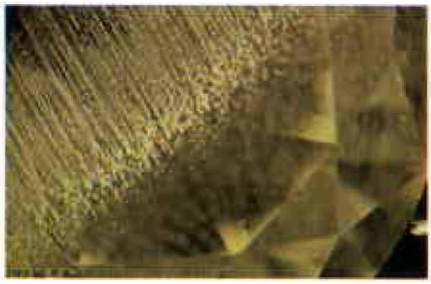
As well as the colorless form, cubic zirconia is available in a wide range of colors from red to violet. Although somewhat brittle, it is easily faceted and should gain in popularity as a synthetic gem material.

Identification of Cubic Zirconia

The major obstacle to overcome in the identification of cubic zirconia or any diamond substitute is the blinding of gemological knowledge that occurs when someone is offered, at a low price, what appears to be a diamond. If a gemologist keeps in mind the many ways in which diamond substitutes may be detected, the chance of making a mistake is minimal. There are many ways to identify cubic zirconia. The most important tests are based on refractive indices, specific gravity, fluorescence and visual characteristics that become apparent both to the unaided eye and under magnification.

If loose, the much higher specific gravity of cubic zirconia is readily

Growth striations in cubic zirconia. Magnification 10x.



Stringers of negative crystal "gas bubbles." Magnification 25x.

Elongated bubbles partially lined with flux. Magnification 15x.

Large gas bubbles like these are rare in cubic zirconia. Magnification 45x.

Several colors of skull melt rough cubic zirconia.

Several colors of faceted cubic zirconia.

apparent. With those familiar with diamond sizes and weights, merely weighing the stone will show its weight to be considerably greater than that of a diamond of the same size. This is sufficient to prove that it is not a diamond. The factors related to refractivity show up in the appearance of the stone, particularly when tilted, and looked at from the side. When one views a round brilliant diamond from just above the plane of girdle, the opposite side of the stone still looks brilliant whereas there is a dark "V" at the center of the opposite side of a cubic zirconia, GGG or YAG. If a stone is laid on its pavilion main facets, and light is directed onto the stone through the table, then the size of the area of bright light coming

through the stone will vary depending on the refractive index of the material. There is a distinctly different appearance and larger circle of light transmission on a cubic zirconia as compared to a diamond. Of course, GGG and YAG have even larger circles. The same situation is true when one tries to read printing through a stone. Again, related to refractive index is the appearance of a stone when immersed in methylene iodide with a refractive index of 1.74. The loss of brilliancy in the cubic zirconia compared to diamond is marked to the eye.

Also, one could get an idea as to the identity of the unknown stone by using a reflectivity meter, such as a Gemeter, or Jeweler's Eye. While reflectivity meters have inherent faults and often give other than an accurate reading, there is a large enough difference between the reflectivity of cubic zirconia and that of diamond to make it easy to distinguish the substitute from diamond.

A carefully polished substitute that is as hard as cubic zirconia should have sharp facet edges, but those that are polished rapidly do show rounded facet edges, a feature never seen on a diamond. The softer substitutes such as strontium titanate and synthetic rutile routinely show the rounding of facet edges and are readily identified as substitutes by them. The girdle surface looks different from that of the bruted girdle on a diamond. There will be no cleavages on a cubic zirconia, which is an important identifying characteristic of diamond. Naturals, another key diamond characteristic, have also been observed on the girdles of cubic zirconias. These can be very confusing, as the photograph below illustrates. The inclusions in cubic zirconia, if present, are also clues to its identification; however, many stones must be studied to become familiar with the common appearance of these.

The reaction of cubic zirconia to ultraviolet radiation varies somewhat from stone to stone. Under long wave, a medium yellow to orange fluorescence is usually encountered. The color is roughly the same, or a little more yellow under short wave, and stones have been noted that while fluorescent to short wave are completely inert to long wave radiation. Unfortunately, some cubic zirconia shows no fluorescence. Another means of recognizing cubic zirconia that is useful to those who have examined a number of stones, is to place the stone table down on a piece of paper with a light overhead. In this way, the cubic zirconia shows much more dispersion than does a diamond of comparable size.

There are several new tests in the process of development that will be useful for identification of diamond versus its substitutes. One is a heat conduction test that should be on the market very shortly. Another is a new liquid developed by the GIA that will write smoothly on a diamond's surface but will bead up on diamond substitutes like cubic zirconia, GGG and YAG. (Gadolinium Gallium Garnet and Yttrium Aluminum Garnet).

Natural on cubic zirconia, Magnification 63.