Apex Crowns

By Tim Smith

Recently I acquired a beautiful blue Afghan fluorite that was already faceted as a square emerald step cut. This had plenty of depth and consequently good colour but was marred by poor meets and a general lack of brightness. I assumed that the depth of the pavilion would permit me to recut it as a retro reflector beneath the girdle whilst retaining a step cut crown for maximum weight retention. As faceters of low refractive index materials will know, retro reflectors permit good brightness by allowing an extra bounce for light rays to bring light back up through the crown. The downside is that they can look ungainly and they do require very deep pavilions.

Having finally got Gem Cad for windows talking to Gem frame, I was confident that I would soon be able to design a bright retro reflector that could be fit into the dimensions of the original stone. However, it became apparent that there was no easy solution to this. I have included the original design "Blue Afghan Fluorite" not so that anyone can cut it but to demonstrate that even a deep pavilion may not be deep enough for recutting as a retro reflector. Having tried several cunning distortions of the basic three fold retro reflector symmetry I abandoned the task as impossible. My brightest effort had been about 48%, little better than the native cut original.

One of the problems with cutting fluorite is that its critical angle is not far off 45 degrees. In a conventional cut there is little room for manoeuvre in the attitude at which rays strike the pavilion for total internal reflection to occur. That is if the rays are coming in vertically from a table facet. However, if an apex crown is selected, one with the table facet omitted, then the crown mains will refract rays entering the crown away from the vertical towards the centre line (except for those near the apex which will be refracted across the centre to strike the "wrong" side of the pavilion).

Anyway, I trashed my retro reflector attempts and redesigned a cut based on keeping the old outline but now having an apex crown and conventional pavilion. This design is included as Apex Square Fluorite for comparison. As you can see, the brightness is dramatically improved to a respectable 75.7%. This turned out to be achievable only by reducing the pavilion mains to a mere 39 degrees, whilst raising the apex facets to roughly 21 degrees (quite steep when you look at the other crown angles). I have used Gem Frame to optimize the angles otherwise I should never have realized the necessity for reducing the pavilion angles to such an apparently low figure.

I am not claiming that 75.7% brightness is the limit for apex crowns in fluorite, as I shall demonstrate. Even with this design, it might have benefited from a steeper crown but the more critical amongst you will have noticed a problem. The original Afghan stone did not have enough crown to permit the angles shown here and indeed, as originally designed I had the crown lower (and the stone less bright). However, because of the thickness of the original girdle and because I needed to recut the outline slightly, I found that I was able to steepen the crown facets to the current more advantageous angles.

The end result of this is that I have a bright blue fluorite with much the same width as before that shows a lot more scintillation than it did. The downside is that it weighs less, the colour is slightly less deep and it has a curious dim central apex point. This is a consequence of the crossing over of the centre line of the stone by light rays that strike near the apex. I have already mentioned this but it is a fault with apex crowns which means that I prefer gems with tables provided, of course, that the original stone is suitably shaped to permit it, which was not so in this case.

So how bright can an apex crown be? As a design exercise I decided to optimize the angle on a stone constructed by facets meeting at a point on both crown and pavilion. A quick check of Datavue 2 indicated that somebody had already had this idea (see Pc01072). Nevertheless, I put it through Gem Frame's paces and discovered that it was brighter in fluorite than quartz with up to 93.8% possible (see Apex double cone). Once again this shows the annoying dark area near the apex.

For fluorite there is no way of getting rid of this dark area. If the apex point is cut away then the pavilion angles behind the table facet thus formed are not steep enough to return light through the table. However, for quartz with its more workable refractive index this is not a problem. I have included a fourth design to go with this article entitled "Mini table double cone". With quartz this gives the astonishing (to me) brightness figure of 94.6%. Having just got my Gem Cad stuff sorted out, I cannot claim to be an expert but that is the highest brightness figure that I have yet seen.

I hope that you have found this interesting. Certainly I was very surprised by the possibilities of apex crowns. I am not the first to experiment with them. I remember Jim Finlayson showing me a similar finding a couple of years ago, although at the time I did not like the dark central area that the apex gave.

If anyone has anything to add to this then I'd love to hear from you. In particular, I would be really interested to hear from anyone who can get a significantly brighter stone than I did from "Blue Afghan Fluorite". As an inducement, I will offer a piece of green Afghan fluorite for the person who gets back to me with the highest brightness.

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