

Spectroscopy - My Quest

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Viewing the spectrum of a gem is one of the most enjoyable aspects of practical gemmology. The transmission of light through a gem and the spreading of that light through a spectroscope can tell the viewer much about the nature of a gem. The spectroscope is one of the most important gem testing instruments and its intelligent use can aid in the identification of many gems.

In the Beginning

Looking back I suppose my quest for an ideal system for visible spectroscopy began in earnest in late 1985 when I visited Dr Jamie Nelson and bought from him a very good prism spectroscope. This instrument gave me very satisfactory views of gem spectra but I had no idea how my activities concerning spectroscopy would evolve so far.

In the 1990's I had the engineering skills to machine an adaptor to attach my EXAKTA SLR camera to the prism spectroscope and record some gem spectra. Whilst I was pleased with my first results I wanted to make a better practical system for recording and presenting gem spectra.

The Small Project

In 2005 Alan Hodgkinson donated a diffraction grating spectroscope. I appreciated the even, linear spectrum over the non-linear spectrum of the prism instrument.

Having a lathe, milling machine, a collection of tubes, lenses and miscellaneous parts, I began to develop and build an improved diffraction grating instrument. I replaced the original fixed-focus slit in the instrument with a much narrower one and mounted this on a rack and pinion focusing block. With this feature I could resolve very fine absorption lines and focus along the whole extent of a spectrum.

I added a low power short focus telescope to the viewing end of the instrument to give me a magnified view of a gem's spectrum. This was a great advance over the small, narrow images I'd seen previously. The gem sample is illuminated by a 100 watt tungsten halogen lamp via a short fiber-optic light guide.

Imaging Skills Improve

Once the important mechanical and optical aspects were completed I moved on to the next developments.

In 2006 I started using NIKON COOLPIX 990 and 995 digital cameras to record spectral images of gems. Gemmologist John Harris demonstrated this method at a Scottish Branch Conference in Perth. So I was eager to do the same with my high resolution spectroscope system.

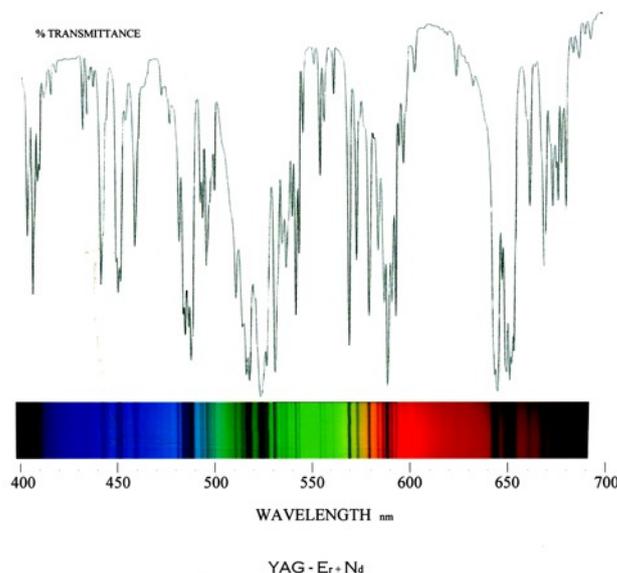
I support the COOLPIX camera above the viewing eyepiece of the spectroscope and take separate focussed images of the blue and red ends of a gem's spectrum.



To help with the focussing I use a filter provided by Dr Jamie Nelson. The filter is YAG, doped with the rare earth elements neodymium and erbium. The spectrum of this filter is spectacular and is shown in Figure 2.

I work with the images using a computer to combine the blue and red ends to form a complete spectrum. I don't enhance the images in any way. Adding a wavelength scale greatly improves the presentation of the spectrum.

The results I now achieve are vastly better than my early attempts using film.



A Larger Project

This work is only part of my spectroscopy story. In the early 1990's I saw a spectrophotometer producing an absorbance curve of a zircon. Dr Brian Jackson was kind enough to donate a redundant UV - Visible range spectrophotometer for me to work with. This instrument was originally intended for biochemistry work. Once it was repaired I was able to record absorbance values for a gem between 400nm and 700nm. My test sample was synthetic ruby.

However, plotting dozens of values by hand onto graph paper was very tedious so I abandoned this method and I didn't use the spectrophotometer for a long time.

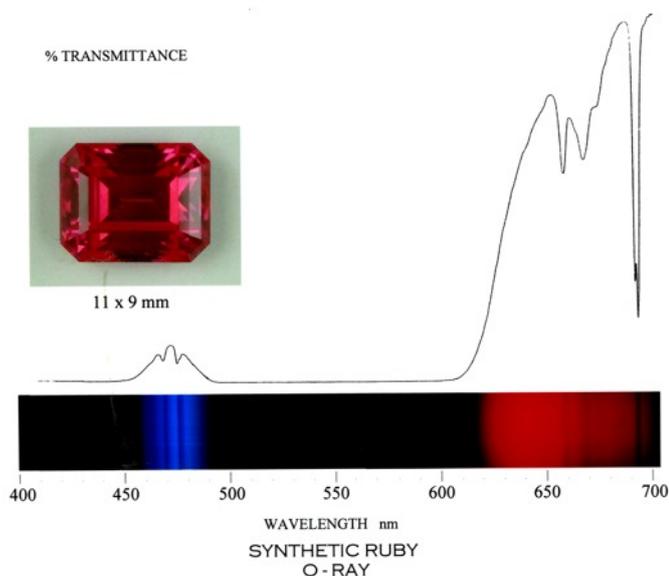
In 2006 Dr Jamie Nelson donated a very good chart recorder for my spectrophotometer work on

gems. Through various trials and tribulations I eventually got the chart recorder to work well with the spectrophotometer in the percent transmission mode to produce a GEMSCAN, which takes 15 minutes to complete. Now I could record in graph form the light transmitted through a gem sample at each wavelength. It is interesting to watch the chart recorder pen become animated when the spectrum has many features. I use the Nd+Er YAG filter to keep the instrument on calibration.

Further work improved the resolution of the instrument to allow the important features in a ruby spectrum to be clearly separated, namely the close doublet in the red with lines at 692.8nm and 694.2nm and the three lines in blue, one at 468.5nm and a close pair at 475nm and 476.5nm. This was a great achievement for me after overcoming many difficulties to get the apparatus working.

Project's End - The Quest Concluded

My efforts to improve the spectroscope, take digital spectral images, learn to use computer and operate the JACKSON - NELSON spectrophotometer began to come together by matching the spectral image of a gem's transmission curve confirm and compliment what is seen on the gem's spectral image. This is well seen in Figure 3.



Where is all this effort leading? I intend to create a library of visible spectra of gems. These will be used for teaching student gemmologists and as bench references. Having such good presentations of gem spectra greatly help in the understanding of what factors contribute to the colour of a gem and help in their identification.

On my long journey my work has been under the watchful guidance of Alan Hodgkinson and Dr Jamie Nelson. Alan has helped me in a variety of ways and with gems having interesting spectra and strongly encouraged me in my quest. Jamie has given me much information on spectroscopy and supplied the Nd and Er YAG filters and the chart recorder. Thanks also go to Dr Brian Jackson for the spectrophotometer.