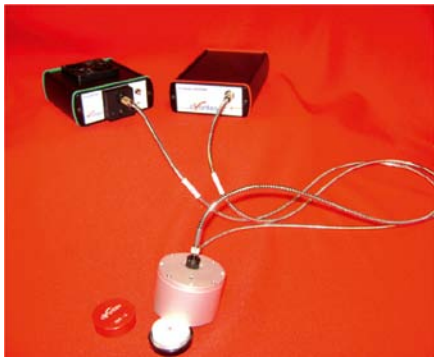
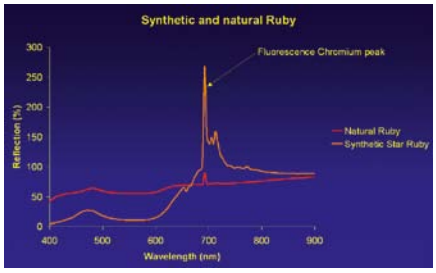
AVANTES
solutions in spectroscopy

APPLICATION NOTE: GEMOLOGY

The measurement needs of the Gemology industry are demanding for series of reasons. Chief among these can be low signal measurement and the need for rapid measurement systems to handle the volume of gemstones measured. Avantes has developed basic measurement tools as well as advanced systems for to meet various gemological requirements. Measurements can be accomplished with fairly simple reflection systems using either integrating spheres or probes all the way to photoluminescence systems requiring lasers and TE cooled spectrometers.





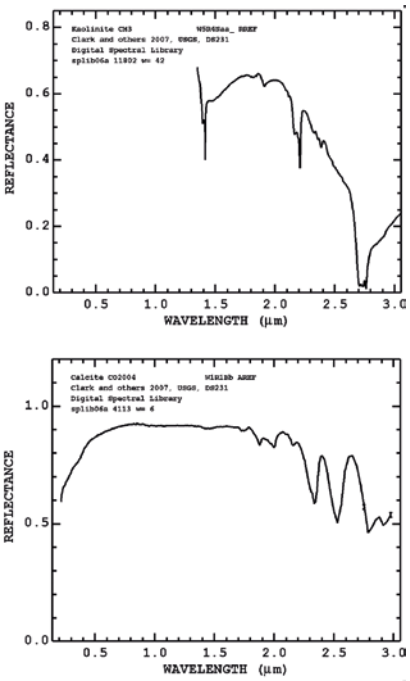
Basic Gemology Measurement

Gemologists often have two basic questions, "What are the characteristics of the stone I'm asked to measure?", and "Are these characteristics natural?" This is because the industry has developed multiple methods to "enhance" stones to improve color and hide imperfections. Methods employed include heat treating, irradiating, resin filling, laser drilling and even simple surface medications such as petroleum product treatments. These modifications are not necessarily bad nor are they always done for nefarious reasons. It may be, for instance, the goal of a jeweler that is making a piece for the client to have a set of well matched stones. As long as the client understands what they are buying, treated stones my be desirable. Each of the treatments has is own use in improving the aesthetics of the stone in question. After all, a gemstone that looks better is what the owner is after. However, it is important to know what, if any, treatments have been done when properly establishing the value of the gemstone. A natural stone that has the same appearance as a treated stone would, for example carry a higher value. Using an AvaSpec-2048 spectrometer, an AvaLight-Hal halogen light source, WS-2-GEM, white reference tile for gemology, and either an FCR-7UV200-2-BX fiberoptic reflection probe or an AvaSphere-50-REFL, reflection integrating sphere, (see above) the spectrum of both a natural and manufactured ruby were produced. It is easy to see in the spectrum to the left that the main chromium peaks (692.8 nm & 694.2 nm) in the two samples are quite different. This simple measurement technique demonstrates that it is easy to compare the two stones and to sort between natural and man made stones. Note that the synthetic stone has a demonstrably stronger response. This measurement was done at room temperature. In some cases, gemstones may be cooled (even to cryogenic temperatures) in order to enhance the measurement technique. A similar measurement can be done with the same equipment to determine diamond type Ia or Ib status. Type Ia or colorless diamonds show strong nitrogen absorption peaks at 415 nm and 478 nm, whereas type Ib, yellow diamonds have wider distribution of nitrogen atoms eliminating these peaks. Other useful peaks are at 592 nm and 741 nm, peaks which indicate artificial coloring has occurred.

Advanced Gemology Measurement

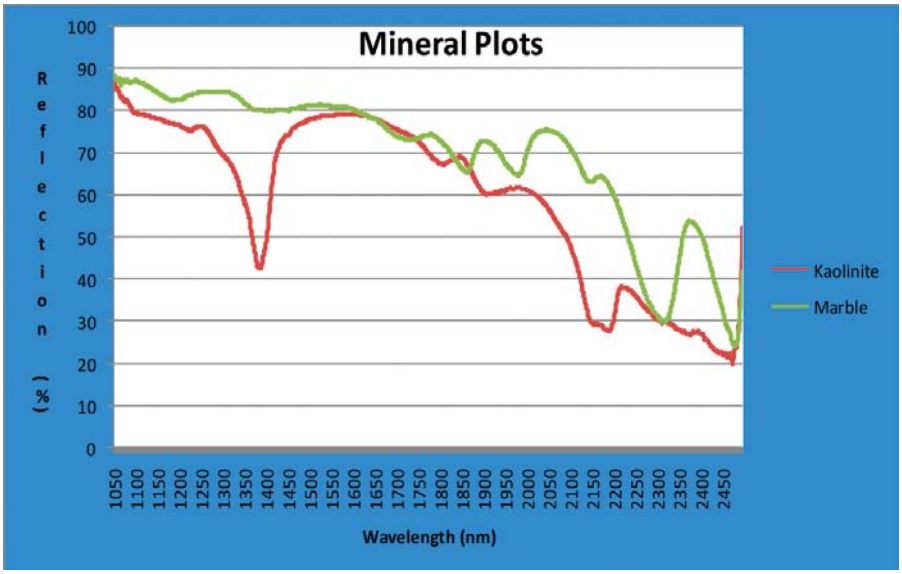
Various entities report the use of photoluminescence systems to detect gemstone characteristics. This technique most often makes use of a laser excitation source, sample chamber, and detection system. The laser wavelength used may depend on the feature (s) being sought. Most often, the chamber will include the ability for cryogenic cooling. The detection system can range from simple cameras to photomultiplier tubes. Avantes has provided systems with various lasers as well as the AvaSpec-3648TEC (thermoelectrically cooled) spectrometer. An AvaRaman-Probe is required as well to filter the excitation source out of the measured data. One example of the usefulness of this technique is the detection of high pressure, high temperature treatment (HPHT). HPHT is sometimes used to improve diamond color, for instance turning brown diamonds into green or yellow diamonds. Since the US Federal Trade Commission requires that all such treatments be disclosed, the chief concern is that stones could be misrepresented as natural or untreated stones. HPHT can be detected with an Avantes low cost, high speed photoluminescence system as it leaves a trace peak at 694 nm.

>



Extending the Application

Gemology measurement is really a subset of the field of minerals measurement. Extensive databases exist for many kinds of minerals. One of the best is provided free of charge by the United States Geological Survey (USGS) which is part of the US Department of the Interior. Their database may be found at this link.: http://speclab.cr.usgs.gov. The spectra above were taken with exactly the same technique described on the previous page using an Avantes reflection probe and an Avantes NIR spectrometer with a standard white reference tile as the reference material. You may note that the reflection percentages differ. This can be corrected with a calibrated white reference tile. The spectral features, however are very nicely duplicated by the Avantes system when compared to the two plots on the right. For Kaolinite, notice the large absorption features near 1,500, 2,100, and 2,500 nm. Marble (calcite) also yields nice replication of the features at 1,800, 2,200, and 2,500 nm.



Application	Laboratory Measurement of Gemstones	UV/VIS/NIR Gemstone Measurement	Raman/Photoluminescence Measurement
Spectrometers	AvaSpec-2048-USB2 (200-1100 nm) AvaSpec-3648-USB2 (200-1100 nm) AvaSpec-3648TEC-USB2 (650-750 nm)		
Resolution	200-1100 nm—0.1 nm and up Full Width Half Maximum (FWHM) 650-750—0.07 nm (FWHM)		
Accessories	AvaSphere-50-REFL FCR-7UV200-2-ME AvaRaman Probes, Laser Dependent	WS2-GEM Integrating sphere IC-DB26 external trigger cable	Cosine func7on di9user Weatherproof Fiber optic Cables