Module B. Colour from the Cosmos

Lesson 9 - Diamond Mineralogy and Gemology

How is Diamond Recognized and Distinguished from Other Materials?

Diamond has some unique properties that distinguishes it from other minerals or gem material fairly readily. That said, because of it's value, people are always trying to find new diamond imitations to make a quick dollar. Thus it is important to be able to recognize and distinguish diamond from all other materials.

The obvious first test is hardness, since no other mineral will scratch diamond. The problem with this technique, however, is that something must be scratched! Ideally, non-destructive tests should be used. The one used by most professional gemologists is thermal conductivity. Specifically, diamond testers have been developed to measure this feature for stones mounted in jewellery. Second, electrical conductivity is used to discern diamond from other high thermal conductivity materials, such as moissanite.

Other properties that can be used diagnostically for diamond include refractive index, dispersion, and its isometric/cubic optic nature. Diamond also repels water and sticks slightly to grease – a property exploited in processing diamond ore. Some diamonds will fluoresce under UV light. However, testing for this property only reveals information 'about' diamond, not whether the material tested 'is' a diamond.

Fluorescence of rough diamonds under UV light. Photo courtesy of the [Gemological Institute of America](http://www.gia.edu/).

Fluorescence of cut and rough diamonds under normal and UV light. Photo courtesy of the [Smithsonian Institute](http://geogallery.si.edu/index.php/en/1107810/).

Materials commonly used to imitate diamond (and their diagnostic properties relative to that of diamond) are moissanite (higher dispersion, greater refractive indices, not isometric), cubic zirconia (lower thermal conductivity), glass (lower thermal conductivity), strontium titanite (lower thermal conductivity) and yttrium-aluminum-garnet (lower thermal conductivity). From this listing, it is clear that thermal conductivity is the best property to test for since it rules out many possible imitations. In recent years the marketplace has started to see application of nanocrystalline diamond onto the surfaces of various gems and imitation material in order to modify colour and imporve durability. This has been causing some problems in the identification and characterization of gem materials.

*The Scientific Method and Diamond Testing?*

Let's see how to apply the Scientific Method (refer to Lesson 5.4) to identification a gemstone of unknown identity. In this example we'll try to identify a brilliant-cut gemstone mounted in a ring that weighs 0.5 carats:

1. *Compile observations*: Making detailed unambiguous and clear observations is vital to any scientific investigation whether that is recording results in a laboratory or describing the geology and mineralogy of a gem bearing rock.
   1. **Our initial observations:**The mounted gemstone is colourless, transparent, reflective, and shows relative high dispersion (fire).
2. *Form a Hypothesis*: This is a provisional theory to explain the observations made.
   1. **Our provisional hypothesis:**This gemstone is either a diamond or diamond simulant.
3. *Test the Hypothesis*: Procedures or tests used to collect data in order to determine if the hypothesis is correct or not.
   1. **Our tests:** Since the gemstone is cut and mounted in a piece of jewellery, it reduces the range of properties that are easy to test. For example, hardness would damage the gemstone, and density would require the gemstone to be loose (not attached to the jewellery). Consequently, we'll test two diagnostic physical properties; refractive index and thermal conductivity.
   2. **Our results:** Refractive Index = 2.42, Thermal Conductivity = 22 W/cm·K (very high)
   3. **Our conclusion:**The results indicate that the gemstone is a diamond since the compiled data eliminate the most common diamond simulants from 'the list' and are within the accepted range for diamond.
4. *Repeated testing*, if needed, on the hypothesis will aid in enhancing the confidence of your conclusions.
   1. **Do you feel that our test results confirm or reject the hypothesis that this is a diamond?**
   2. **If the tests were inconclusive or reject the hypothesis that the identity of the unknown is diamond, what other properties could be tested?**