

## **How to facet gem-quality chrysoberyl: Clues from the relationship between color and pleochroism, with spectroscopic analysis and colorimetric parameters**

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### **ABSTRACT**

Pleochroism plays an important role in determining the face-up visual color appearance of faceted, optically anisotropic (non-cubic) gemstones. One area that has received little attention is the interplay between pleochroism and the so-called alexandrite effect wherein the perceived color of a mineral changes with different lighting conditions (i.e., daylight vs. incandescent light). In this article we have collected ultraviolet/visible/near-infrared (UV-Vis-NIR) spectra of a gem-quality, synthetic Cr-bearing chrysoberyl crystal along its three crystallographic axes. We use these spectra to calculate the color and to quantify the color change that would be observed in a wafer or faceted gemstone in any orientation and for any prescribed path length of light between 1 and 25 mm. We describe the method used to perform these calculations and give an overview of color science and color space as it pertains to mineralogy and gemology. The data collected here are used to predict the optimum orientation for a wafer or a faceted alexandrite gemstone to produce the maximum color change sensation between daylight and an incandescent light source. We find that a wafer oriented with the unpolarized light-path-length perpendicular to the *a*-axis exhibits the strongest color change but that the color change is weaker parallel to the *a*-axis. Pleochroism in a faceted stone will mix light traveling in different directions. This relaxes requirements to orient a stone along the “best” direction, but it is still found that stones cut with their table to culet direction oriented perpendicular to the *a*-axis show the best color-change while orientation parallel to the *a*-axis produces weaker color change. Nonetheless, there is a wide range of “acceptable” orientations and no single “best” direction for a faceted gemstone. The results of this study demonstrate the complex nature of color in minerals and shed light on the intricate interplay between several factors including pleochroism, lighting conditions, light path length through a transparent sample, and chromophore concentrations. The use of the techniques outlined here can lead to a better understanding of the color sciences in the mineral world in general.

**Keywords:** Alexandrite, alexandrite effect, pleochroism, Usambara effect, visible spectroscopy, colorimetry