GEMOLOGICAL CHARACTERISTICS, AND THE CAUSE OF IRIDESCENCE IN JEWELRY MADE FROM ABALONE SHELL

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Introduction

Abalone shell is classified as an organic gemstone characterized by its distinctive iridescence, which produces a beautiful play of color similar to opal; this phenomenon is caused by light interference within the nacreous structure. However, due to the inherent physical fragility of the shell, it is commonly produced as assembled gemstones to enhance durability. This research performed delamination of these assembled materials to facilitate effective analysis, selecting samples with varying iridescent hues to examine the aragonite crystal structure via Scanning Electron Mircroscopy (SEM) and to investigate light absorption properties using UV-Vis-NIR spectroscopy, ultimately identifying the relationship between nacre layer thickness and the resulting color spectra.

Material and Methodology

- The study utilized 10 samples of assembled gemstones, with 5 samples exhibiting distinct iridescent colors separated from their adhesive layers to enhance analytical precision.
- Standard gemological properties
- Optical analysis
  - Uv-Vis-NIR Reflection spectra
- Chemical and structural analysis
  - SEM-EDS

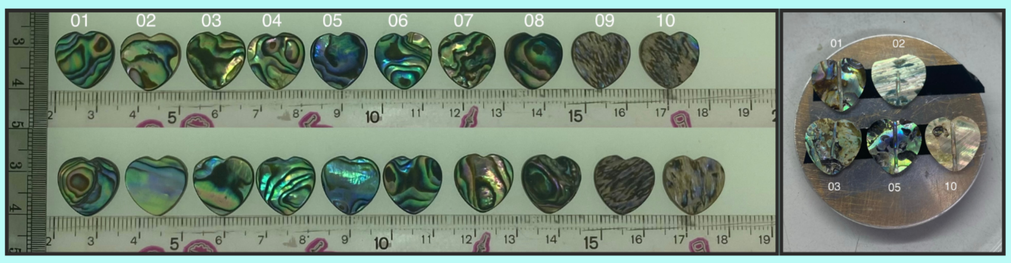


Figure 1 : 10 samples before delamination (left); 5 selected samples with distinct iridescent hues after delamination (right).

Result

• Gemological properties

The average specific gravity of the 10 samples prior to delamination was 2.269; however, after selecting 5 samples with distinct iridescence for delamination, the average specific gravity increased to 2.495. Despite this increase, the values remain lower than the standard range for natural abalone shells (2.700 – 2.900), which can be attributed to the influence of residual adhesive and resin remaining on the samples. In addition they are inert under both short wave and long wave ultraviolet light.

• Uv-Vis-NIR

Optical analysis via UV-Vis-NIR spectrophotometry revealed absorption spectra in the 230–280 nanometer range, attributed to the organic protein matrix located between aragonite crystals that provides structural strength. Additionally, distinct reflection peaks were identified across the samples, which determine the varying iridescent color spectra based on the specific thickness of the nacre layers.

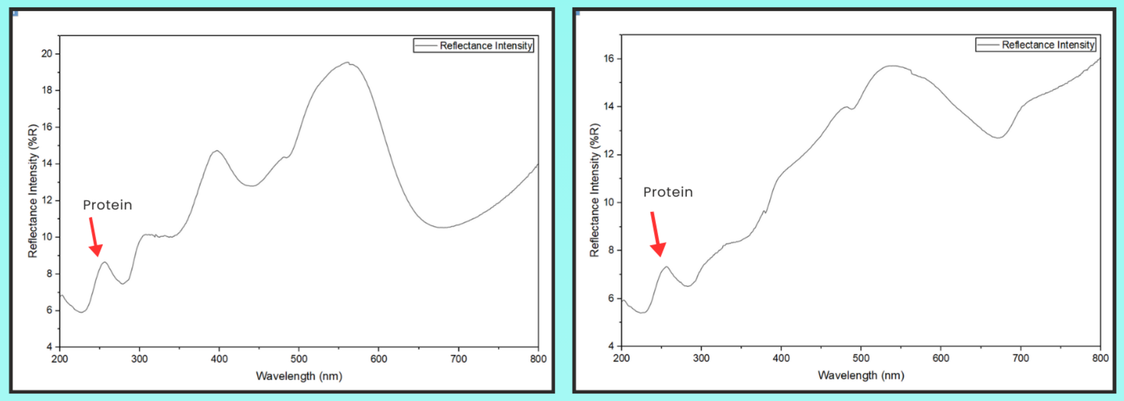


Figure 2 : UV-Vis-NIR reflection spectra of sample Abs01 (left) and sample Abs02 (right).

• SEM - EDS

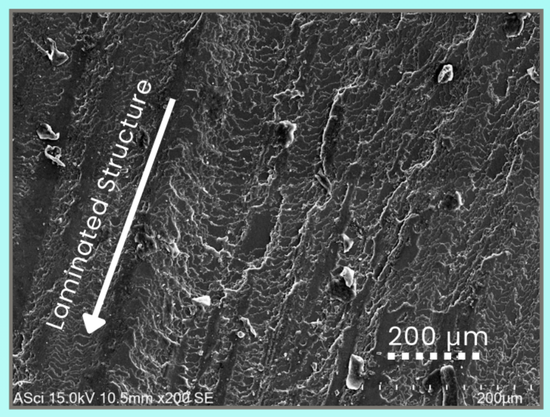


Figure 3 : Scanning electron microscope image of sample Abs01

SEM analysis identified Calcium (Ca), Oxygen (O), and Carbon (C) as primary elements. The results confirm that iridescence is caused by the internal laminated aragonite structure within the nacre, which induces light interference and diffraction to create the shell's unique play of color.

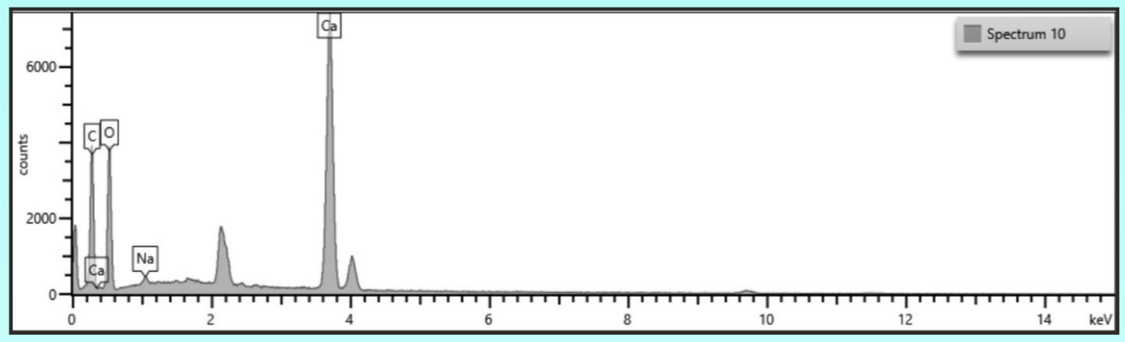


Figure 4 : EDS spectrum of sample Abs01

Conclusion

- SEM analysis confirms that the iridescence originates from light interference within the highly ordered aragonite structure of the nacre layer.
- UV-Vis-NIR spectroscopy indicates that thinner aragonite layers primarily produce blue coloration, whereas thicker crystalline plates typically manifest as green and red hues.

This study provides a deeper understanding of the gemological characteristics and the fundamental causes of iridescence in abalone shell jewelry, which is widely utilized within the gemstone industry.

References

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