Dyed purple Jade (Lavender jade or purple “Fei Cui”) from Mandalay's jade market, Myanmar

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Introduction

Jade or "Fei Cui" are trade names for a stone that typically contains only one or more main mineral components, including jadeite, omphacite, and kosmochlor. These mineral components exist in the form of small crystallites tightly packed together (aggregate), with many grain boundaries between them. As a result, jade also known as “fei cui” commonly exhibits varying degrees of translucency. Not only green jade, but also purple jade is increasingly popular in the gem market. This is due to its beautiful, rare and unique colouration. Moreover, there is a belief that purple jade (also known as lavender jade or purple “fei cui”) is an auspicious gem, bringing good luck to the person who owns or wears it. Due to the rarity of such shades in nature, high-quality purple jade holds significant value and is in demand in the current market. Since 2023, The Gem and Jewelry Institute of Thailand (Public Organization) or GIT, has received reports from entrepreneurs indicating an increase in the quantity of various shades of purple jade entering the market compared to previous years. Furthermore, there is a significant possibility that some of the purple jade available in the market may have been artificially enhanced colour through dyeing processes. This situation has raised significant concerns within the trade, impacting both entrepreneurs' and consumers' confidence in the authenticity of purple jade available in the trade and market.

Materials and Methods

GIT received a collection of purple jade samples, acquired from a dealer at the Mandalay Jade and Gemstone Market in Myanmar. The collection comprises 15 samples with a weight range of 3.30 to 9.16 ct. Among these, three samples were identified as natural purple jade while the remaining twelve were suspected to have been dyed, as illustrated

Figure 1. 12 Dyed purple jade samples from the Mandalay jade market in Myanmar, ranging from 0.11 to 1.04 ct.
Photo by M. Seneewong-Na-Ayutthaya.

in Figure 1. To determine evidence of dye treatment, the samples were analyzed using both microscopic examination and advanced instruments, including a Raman microscope spectrometer (Renishaw inVia), FTIR spectrometer (Thermo Scientific, Nicolet iN10) and UV-Vis-NIR spectrophotometer (PerkinElmer, Lambda 1050).

Results and Discussions

All samples have been confirmed to be natural jadeite-jade through basic instrument testing. Fluorescence testing revealed that all samples were inert when exposed to short-wave and long-wave UV radiation. Visual observation of the samples with the naked eye and a 10x loupe revealed that they can be grouped into two categories: dark purple and light purple. Most of the samples exhibited irregular colour and texture characteristics, typical for jade which is dyed. Poor-quality jade, characterized by pale colour and larger crystal grain size, are often treated by a dyeing process. This textural property allows the dye to penetrate and spread more effectively along the crystal grain boundaries. Additionally, it's worth noting that jade with purple colour is rare in the famed jade deposits in Myanmar. High-magnification observation under a gem microscope, as illustrated in Figure 2 , revealed distinct internal characteristics. The natural purple jade sample exhibited a light purple colour that is smoothly distributed among the fine, small crystal grains. The more intense purple jade samples revealed evident features indicating that they were dyed, such as distinct colour patches and concentrations along grain boundaries as a result of the dyeing treatment.

Subsequently, the purple jade beads were cross-sectioned to study the extent of dye penetration, as represented in Figure 3. The results revealed significant colour modifications in all the purple jade samples through the dyeing treatment. Strong evidence of dye infiltration was observed within the central area of the samples, with the intensity of the dye gradually decreasing to a very light colour toward the edge of the samples (in the thinnest area of the cross-section). Based on the observed characteristics of the dye penetration we assume that a vacuum-assisted dyeing technique was used. For this, the jade bead is first placed in a vacuum chamber to remove air, water, or small particles from the grain boundaries. This pre-treatment enables the jade to absorb the dye more effectively, as the dye can quickly

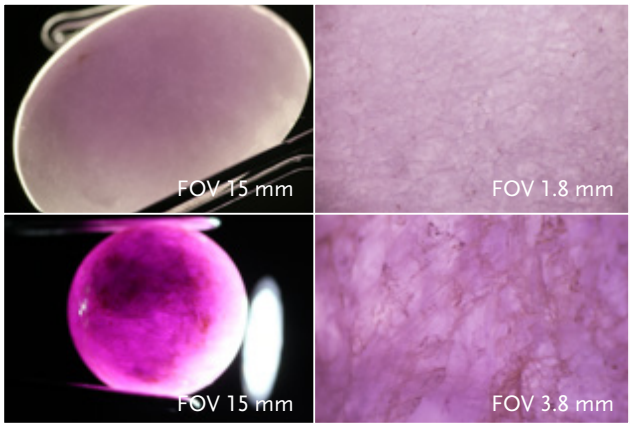

Figure 2. (top) Natural purple jade exhibiting a light purple colour with smooth distribution in fine crystal grains, and (bottom) dyed purple jade displaying areas of colour patches caused by dyeing, with dye concentration observed along the crystal grain boundaries. Photomicrographs by M. Seneewong-Na-Ayutthaya.

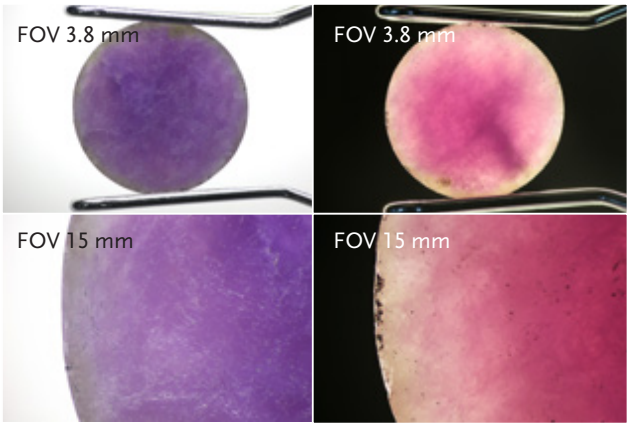

Figure 3: A cross-section of dyed purple jade sample was studied in bright-field and dark-filed illumination to observe the extent of dye penetration. Dye concentration was observed in the centre of the bead, while a pale colour was evident near the surface of the bead. Photomicrographs by M. Seneewong-Na-Ayutthaya

penetrate between the crystal grain boundaries (Ou Yang & Humphrey, 2015) and thus allows the dye to penetrate deeply into the crystalline texture of the jade bead. Furthermore, the lighter colouration observed at the edge of the cross-section sample may result from cleaning procedures commonly employed during the process of making jade jewelry. Specifically, washing the bead with a mild acidic solution, such as plum juice, is a traditional practice. used to clean off various chemical residues from the grinding and polishing process (Yan, 2019).

An additional experiment involved soaking purple dyed samples in ethyl alcohol for 48 hours. After this test it was observed that the jade samples displayed their original colour (pale yellowish green) near the edge of the samples (see Figure 4) as they had assumingly before the dyeing treatment.

Figure 5 displays the absorption spectra of a purple jade of natural colour (spectrum at the bottom), a reference sample of dyed purple jade, and two spectra of dyed jade

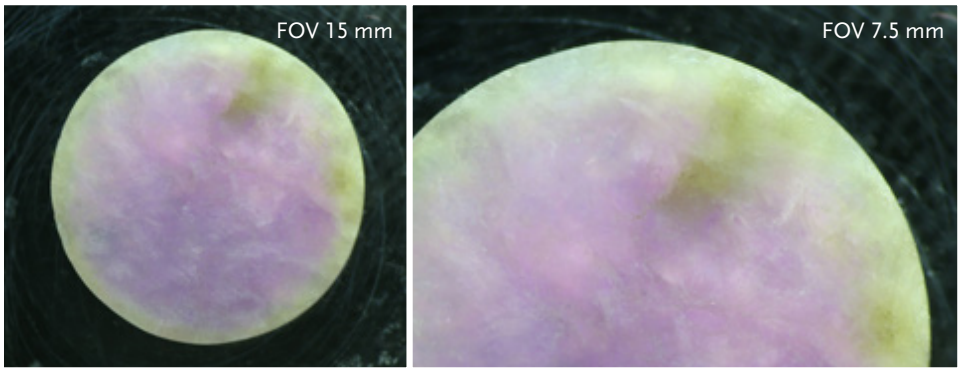

Figure 4: A purple dyed jade cross-section after soaking in ethyl alcohol for 48 hours. It clearly displays its original colour before the dyeing treatment along the edge of the sample. Photomicrographs by M. Seneewong-Na-Ayutthaya

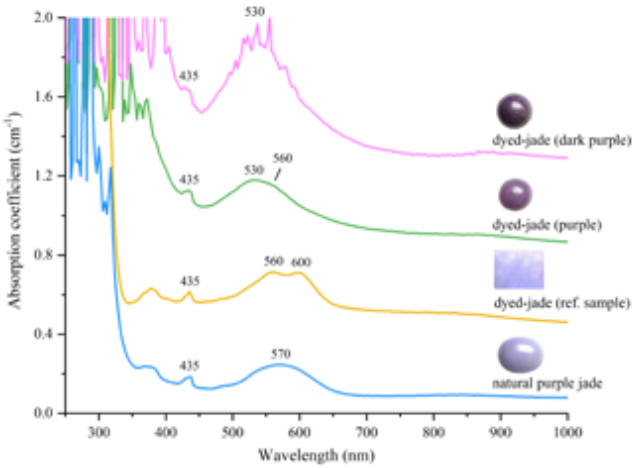

Figure 5: UV-visible spectra of natural purple jade and dyed purple jade samples.

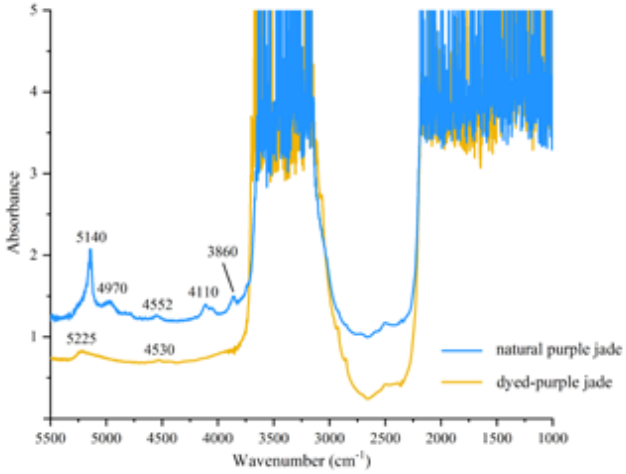

Figure 6: FTIR spectra of natural purple jade and dyed purple jade samples.

of purple and dark purple colour. In dyed samples investigated for this study, a main absorption band was observed at 530 (with a small shoulder at 560 nm) related to the purple dye. The dyed reference sample of light purple colour exhibits two broad absorption bands at 560 and 600 nm, respectively. In contrast to this, the purple jade of natural colour exhibits an absorption peak at 573 nm due to the presence of manganese (Mn^{3+}), causing the purple colour in natural jade, and in addition a peak at 453 nm, which represents iron (Fe^{3+}) (Lu, 2012; Abduriyim *et al*., 2017). The comparison of the absorption spectra clearly indicates that the purple jade beads investigated had been dyed. Figure 6 shows the FTIR spectra of a dyed purple sample compared to the untreated natural purple jade. A small wax-related appears around 2900 cm^{-1}, with no absorption peaks indicating polymer treatment (Zhang *et al*., 2013; Seneewong-Na-Ayutthaya, 2022; Promwongnan *et al*., 2023). This suggests that the dyed purple jade sample can be classified as C-Jade, a type of jade that has only been enhanced in quality through dyeing.

Concluding remarks

From the analysis of purple jade (also known as lavender jade or purple "fei cui") samples from the Mandalay Jade Market in Myanmar, it was suspected that the colour had been modified by dyeing. From a total of 15 purple jade beads investigated for this study, 12 samples were found to be impregnated with purple dye. The experimental results showed that the dye penetrated deeply into the jade, likely facilitated by using a vacuum technique to help spread the dye along crystal grain boundaries. Consequently, this type of treatment can be identified through careful microscopic examination and confirmed using standard spectroscopic techniques by experienced gemmologists.

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