# Spectrophotometric measurements of faceted rubies: critical review of an immersion technique

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Referring to the paper 'Spectrophotometric measurements of faceted rubies' by A. Banerjee, J. Himmer and H.-W. Schrader (*J. Gemm.*, 1985, **XIX**, 6, 489–93) and to the abstract of this article by C.M. Stockton (Gems & Gemology, 1985, **XXI**, 3, 182) and in reply to the Letter to the Editor by Banerjee and Schrader (*J. Gemm.*, 1986, **20**, 2, 135–6), four critical notes must be added to the discussion. For this purpose, a transmittance diagram of two faceted Burma rubies is used to compare the immersion spectra published by Banerjee *et al.* (one of them, Figure 3, shown here as curve A) with a spectrum recorded in air by G. Bosshart (curve B).

1) Banerjee *et al.* (1985) intended to demonstrate immersion in methylene iodide as an advantageous general technique for getting straylight-free absorption diagrams of faceted gemstones in the 400 to 800 nm range. While, for the visible area, we do not negate the feasibility of good-quality absorption spectra of faceted gemstones immersed in certain colourless, light-stable heavy liquids, the two published ruby curves (Figures 3 and 4, pages 492 and 493) do not prove the advantages of the method and should not be termed 'clean spectral diagrams' (Stockton, 1985): both spectra are misleading in part. They show a strange additional transmission peak roughly where the slender chromium absorption band is positioned in any undisturbed ruby diagram (see curve B). The phantom transmission in curve A is an unexplained artefact most likely caused by the methylene iodide immersion technique.

In addition, Figures 3 and 4 are insufficiently resolved: the chromium doublets at 475/476 nm and at 693/694 nm in fact are wide singlets. The alert spectroscopist also notes that the abscissa in Figure 3 (here as curve A) is in error by at least +40 nm. This would be the transmittance diagram of a greenish or colour-changing corundum and not of a ruby.

2) It is not correct to state that absorption curves of faceted gemstones in air in general are negatively affected by 'refraction and reflection of the light beam' and 'cannot be easily reproduced'. Recording in air is successfully done by an increasing number of gemmological laboratories around the world (for the sake of comparability, however, preferably in the absorbance and not in the transmittance mode). In fact, a skilled operator is able to record detailed and fully polarized absorption spectra in air, all the way down to 280 nm and unpolarized curves even down to 200 nm.

3) Immersion techniques require a set of wide, fairly expensive UV silica glass cells and are cumbersome in terms of fine adjustments of the stone in the light beam. Immersion does not eliminate scattering effects caused by condensed tiny inclusions nor by strong internal growth inhomogeneities and fluorescence.

According to the authors' experience, immersion does not even improve the UV/Visible spectra of cut stones with inferior polish, nor of rough stones, in an obvious manner.

4) Among the *liquids* a gemmologist usually knows, methylene iodide is the least suited for immersion. It is not entirely colourless and it reacts to light and heat by darkening. Transmission ends at approximately 440 nm at best (and thus is completely inappropriate for UV spectra of rubies). Dispersion of light into the spectral colours is high (a problem encountered in immersion microscopy of inclusions also). Like other heavy liquids, it has a strong and unpleasant odour, is expensive and not totally harmless with respect to toxicity. The only property of methylene iodide which is advantageous for the recording of gemstones like rubies, is its high refractive index ($n_D$ 1.734 at 23°C).

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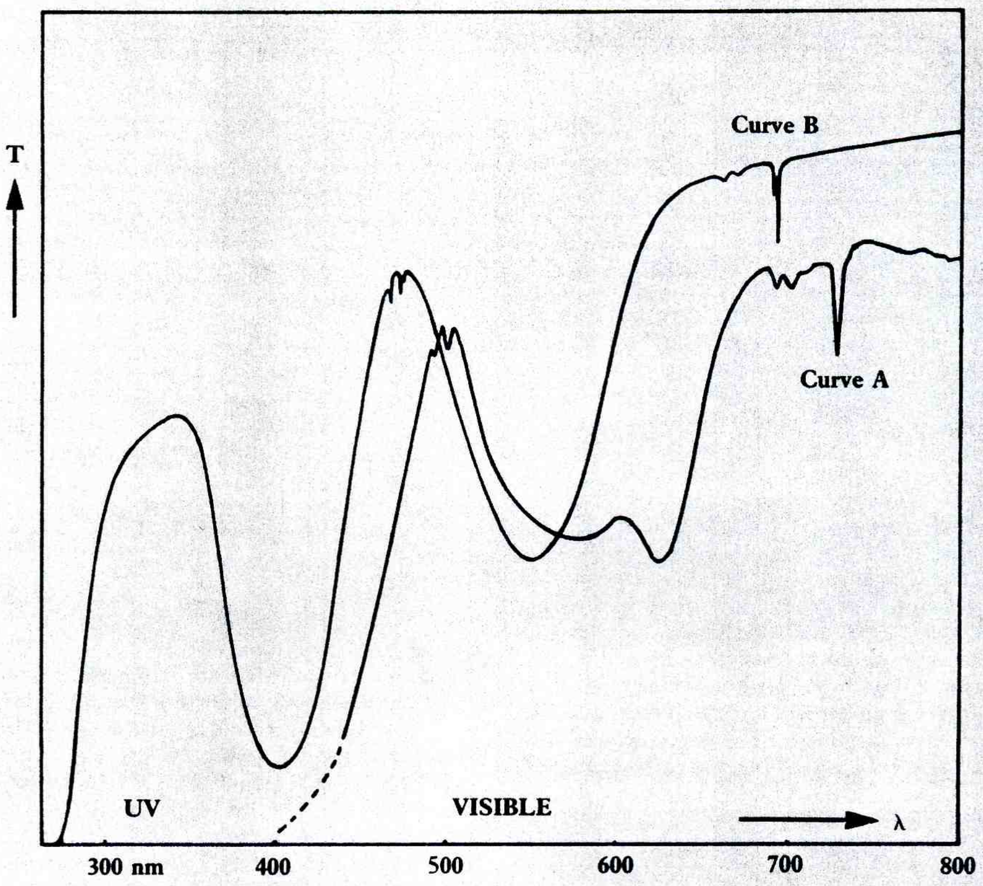


Comparative transmittance spectra of two faceted rubies from Burma, recorded at ambient temperature in methylene iodide immersion by Banerjee *et al.* (1985), Curve A, and in air by G. Bosshart, Curve B.

Bromoform has better transmittance (down to 350 nm) but a markedly lower refractive index ($n_D$ 1.590 at 23°C).

Perchloroethylene ($C_2Cl_4$), a colourless liquid of medium refractive index ($n_D$ 1.505 at 23°C) and of lower toxicity than carbon tetra-chloride (therefore used in dry cleaning), can be considered as an option for extraordinary cases, since it transmits at least to 300 nm and is stable.

Own immersion experiments dating back to 1974 and correspondence of one of the authors (GB) with the late B.W. Anderson as early as January 1978, showed distilled water to be that 'very useful dream liquid' with the most favourable combination of properties. It is colourless, transmits to at least 240 (210) nm, is stable to light, ultraviolet radiation and heat (during recording and storage), has low dispersion, is universally available, cheap, non-toxic, odourless and non-fluorescent. The low refractive index ($n_D$ 1.329 at 23°C), however, even disqualifies this liquid as an ideal immersion medium.

## Conclusion

From our own observations, we therefore conclude that immersion is an unnecessary complication during absorbance measurements on rough and cut gemstones and especially is of no advantage for the recording of UV spectra of faceted rubies.

Experience in properly positioning the stones, varying from specimen to specimen in the degree of difficulties presented by the external and internal properties, efficiently replaces the need for immersion techniques.

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