NOTES
· AND ·
NEW TECHNIQUES

SYNTHETIC OR IMITATION? AN INVESTIGATION OF THE PRODUCTS OF KYOCERA CORPORATION THAT SHOW PLAY-OF-COLOR

By Karl Schmetzer and Ulrich Henn

The products of Kyocera Corp. that show play-of-color were investigated to determine if the materials are truly synthetic opal or rather are opal simulants. The authors propose that, because these materials contain no water, they do not match the composition of natural opals and, thus, should be designated opal simulants. The gemological properties of the samples examined are also provided, including those by which the Inamori material can be separated from natural opal.

Gem materials showing play-of-color are manufactured in Japan by Kyocera Corp. and sold under the trade name Inamori Created Opals (figure 1). The first gemological reference to these materials was by Fryer et al. (1983); in this short note, the samples were accepted as being synthetic opal, as stated by the manufacturer, entirely on the basis of their gemological properties. However, it has been suggested by one of the present authors and his coworkers that for non-single-crystal synthetics it is necessary to determine both the chemical composition ($SiO_2 \cdot nH_2O$ for opal) and the phases present. Only when a man-made gem material is essentially, if not absolutely, identical in these respects to the natural gemstone is it acceptable as a synthetic counterpart.

A working definition for a distinction of true synthetic gem materials from imitations was proposed by Nassau (1976, 1977). This proposal included observations at five different magnifications ranging from the atomic level to inspection by the naked eye. It also included the following four criteria on the basis of which man-made gem materials must be essentially identical to their natural counterparts to be labeled *synthetic*: (1) chemical composition, (2) crystal structure, (3) submicroscopic structures, and (4) appearance to the naked eye. These criteria have been applied in discussions of non-single-crystal materials such as man-made turquoise (Schmetzer and Bank, 1980, 1981; Lind et al., 1983a and b), man-made opal (Schmetzer, 1983a, 1984), and man-made lapis lazuli (Schmetzer, 1983b, 1985).

In the case of the products of Gilson that show play-of-color, the man-made materials do not match natural opals in chemical composition, primarily because of the absence of distinct amounts of water. Thus, in the opinion of the authors, these substances should be designated

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Figure 1. These three examples of Inamori Created Opal are produced by the Kyocera Corp. of Kyoto, Japan. The sample with the black body color weighs 3.96 ct and measures 10 × 12 mm. Photo © Tino Hammid.

opal simulants rather than synthetic opals (Schmetzer, 1983a, 1984). The present study was conducted in an attempt to clarify the nomenclature for the man-made products of Kyocera Corp. that are known as Inamori Created Opals in the trade and have been represented as synthetics.

MATERIALS AND METHODS

Gemological properties were determined on several samples of the Kyocera product; on the basis of these tests, play-of-color, and body color, four types were identified (see table 1), with two to four samples of each type selected for additional testing. Structure was then determined by X-ray diffraction analyses with a Debye-Scherrer camera; semiquantitative chemical investigations were carried out using the energy-dispersive analytical system of an ARL-SEMQ electron microscope. Thermogravimetric analyses were undertaken between 20° and 1000°C by means of a DuPont thermobalance.

GEMOLOGICAL PROPERTIES

Visual appearance, refractive-index values, and specific-gravity values of the samples investigated are given in table 1. The refractive indices of the white and colorless (body color) samples were found to be close to the upper limit, but still within the range, for natural opals; the refractive indices of the black samples were found to be

TABLE 1. Gemological properties of the man-made products of Kyocera Corp. that show play-of-color.

Sample types[a]	Body color	Play-of-color	Refractive index[b]	Specific gravity[b]
A	Colorless	Green, blue, violet	1.459–1.460	2.20–2.22
B	White	Green, blue violet	1.460	2.21–2.22
C	Black	All spectral colors	1.463	2.23
D	Black	Green, blue, violet	1.466	2.24

[a]*Two to four samples of each type were tested.*
[b]*Ranges are for different samples of the respective type.*

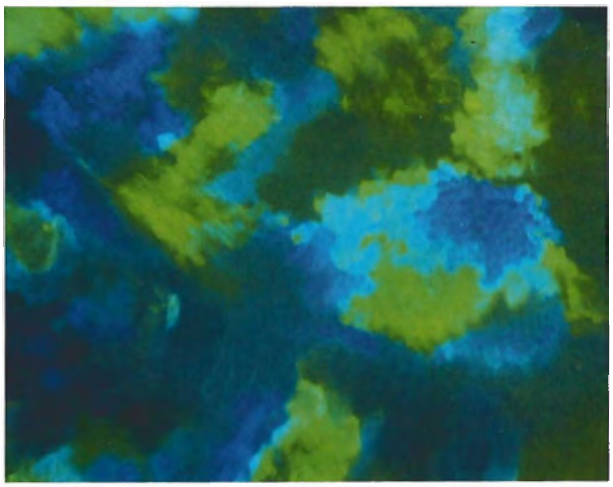
slightly higher than the highest values determined to date for natural opals (Frondel, 1962; Deer et al., 1963; Tröger, 1971; Phillips and Griffen, 1981). For all of the samples, the specific gravity determined slightly exceeds that of natural opals.

The refractive-index and specific-gravity values for the Inamori products are distinctly higher than the values for the Gilson products, which lie in the range of about 1.440 and 2.04, respectively (e.g., Eppler, 1974; Scarratt, 1976). However, when viewed with a microscope, the Inamori products show features that also appear in the Gilson material. Specifically, the Inamori cabochons reveal a diagnostic columnar structure that is evident when the samples are viewed at various angles to the curved surface of the cabochons (figure 2). Perpendicular to this columnar structure are mosaic-like patterns with distinct boundaries between different "grains." Each "grain" is divided into several "subgrains." In gemology, this pattern is often referred to as a "lizard-skin, "chicken-wire," or "honeycomb" structure (figure 3). Although this pattern has been observed in a few natural opals (Scarratt, 1986), it is usually considered characteristic of opal imitations.

All of these properties are consistent with the data provided by Fryer et al. (1983) and are considered to be of diagnostic value. In most cases, a combination of microscopic examination with determination of refractive index and specific gravity is sufficient to distinguish the Inamori product from natural opals.

Figure 2. The columnar structure of the color "grains" is evident in this Kyocera opal imitation with black body color. Magnified 20×.

Figure 3. This Kyocera opal imitation with black body color shows the mosaic-like patterns with distinct boundaries between different "grains," as well as the pattern referred to as "lizard-skin," "chicken-wire," or "honeycomb" that is caused by the subdivision of each color "grain." This pattern is considered characteristic of man-made opal. Magnified 40×.



COMPOSITION

X-ray powder diffraction analyses of the samples selected for detailed examination revealed no distinct pattern; that is, all four types are amorphous to X-rays. Chemical investigations indicate silica as the dominant component; no other major constituents were detected (as is also typical of most natural opal). Thermogravimetric analyses of all the samples showed no loss of weight up to 1000°C (see figure 4, which also includes a typical dehydration curve for natural opal from Australia). These results indicate that no water is present in any of the samples of Kyocera material that were tested.

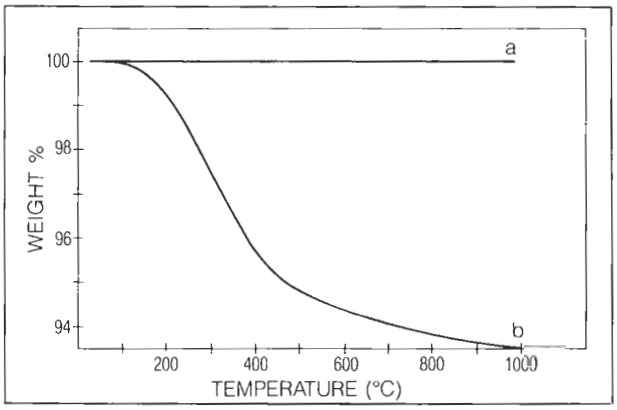


Figure 4. The absence of water in the Kyocera opal imitation is evident in this comparison of the curve produced by thermogravimetric analysis for a sample of the man-made material with black body color (a) with that of one produced for a natural Australian opal of white body color (b).

CONCLUSIONS

The products of Kyocera Corp. that show play-of-color consist of amorphous silica glass without any admixtures of water. Comparison with the properties of lechatelierite, an amorphous and anhydrous form of silicon (R.I. = 1.46, S.G. = 2.2) further supports this conclusion. Because of the complete absence of water, these man-made materials are not within the compositional range of natural opals (see, e.g., Schmetzer, 1984). Consequently, the authors propose that these products of Kyocera Corp. should be designated opal simulants rather than synthetic opals. It is not sufficient that in both natural opals and (as determined by the authors) the Kyocera opal imitations the play-of-color is caused by a closely packed array of uniformly sized amorphous silica spheres. In the opinion of the authors, a true synthetic must be essentially identical in structure and composition to its natural counterpart.

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