FIG. 1 **Ladies' fan before treatment. Black ostrich feathers and cellulose nitrate sticks.**

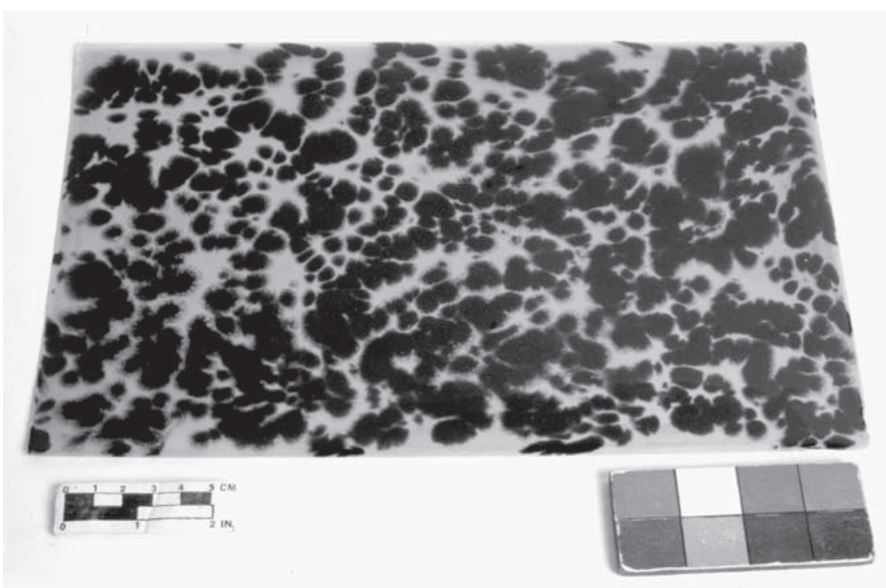

FIG. 2 **A full sheet of the Tor-tis™ material, measuring 7.5 x 12 inches.**

A New Material for Producing Faux Tortoise Shell Fills

Thomas J. Braun

In July of 2001, during a class taught by Smithsonian furniture conservator Don Williams, a student mentioned that he had success filling losses to tortoise shell inlay on furniture using faux tortoise shell sheet stock, which he had purchased from musical instrument supply catalogs. Having never worked with tortoise shell or faux tortoise shell, it seemed like a good tip to keep in mind. In the winter of 2002, a 19th-century ladies' fan was brought to the Daniels Object Conservation Laboratory at the Minnesota Historical Society for treatment. The fan was made out of black ostrich feathers and faux-tortoise shell cellulose nitrate plastic. As seen in the photo of the fan before treatment (fig. 1), the cellulose nitrate had begun to deteriorate, shatter, and release acidic vapors. Although the feathers were still in excellent condition, until the fan came to the lab, the plastic parts were considered untreatable and a total loss, due to the extensive and irreversible damage. After consulting the appropriate curator, it was decided that if an appropriate material could be found to replace the original faux tortoise shell, it would be acceptable to replace all of the original plastic material, since there was no hope of preserving the cellulose nitrate before it completely deteriorated, and potentially caused damage to the feathers.

Several luthier supply catalogs were searched for faux tortoise shell sheet stock. Usually, there were several drawbacks: it was very expensive, often already cut into the shape of a pick or a pick-guard (which was too small for the fan), and it was frequently made out of cellulose nitrate, which was of course unacceptable. However, Luthiers Mercantile International (LMI), a supplier based in California, carried a material that was intriguing (fig. 2). It is called Tor-tis™, and LMI claimed to be the exclusive distributor. It was sold in large sheet stock (up to 7½″ x 12″) that came in several thicknesses between 1⁄16″and 1⁄32″, which tends to be rather thin for most tortoise shell inlays. However, they did not specify what it was made of, only stating that it was "highly refractive, chemically inert, untouched by all solvents, …and backed by 25 years of industrial use." Lastly, it was not cheap, the largest sheet, sheet measuring 7½″x12″, cost over $50, though this is not a bad price if it proved to be appropriate for conservation.

Two sheets of the "light" colored grade were ordered from LMI. When the company was asked what it was made of, they provided the telephone number of the manufacturer, Colette Hanson, apparently the sole proprietor of Turtleworks, based in Bloomington, Indiana, where Tor-tis™ faux tortoise shell is made. After speaking with Colette, she indicated that she could make thicker samples (up to 1⁄8″ thick), and that she could even imitate specific colors and patterns in original samples of tortoise shell or faux tortoise shell. Apparently, for some stringed instrument makers and restorers, it is extremely important to imitate the exact original graining in a pick guard. Colette was very helpful, and stated that her product was made from a two-part epoxy, and although she would not divulge the manufacturer, she did send some thicker samples (up to 3⁄32″ thick) which were more consistent with the thicker tortoise shell often used in inlays.

After consulting with James Martin of Orion Analytical LLC in Williamstown, Massachusetts, a sample was analyzed with Fourier Transform Infrared analysis (FTIR) to verify if it really was epoxy, what kind of epoxy, and to see if the colorant used also could be identified (fig. 3). In figure three, the spectra for

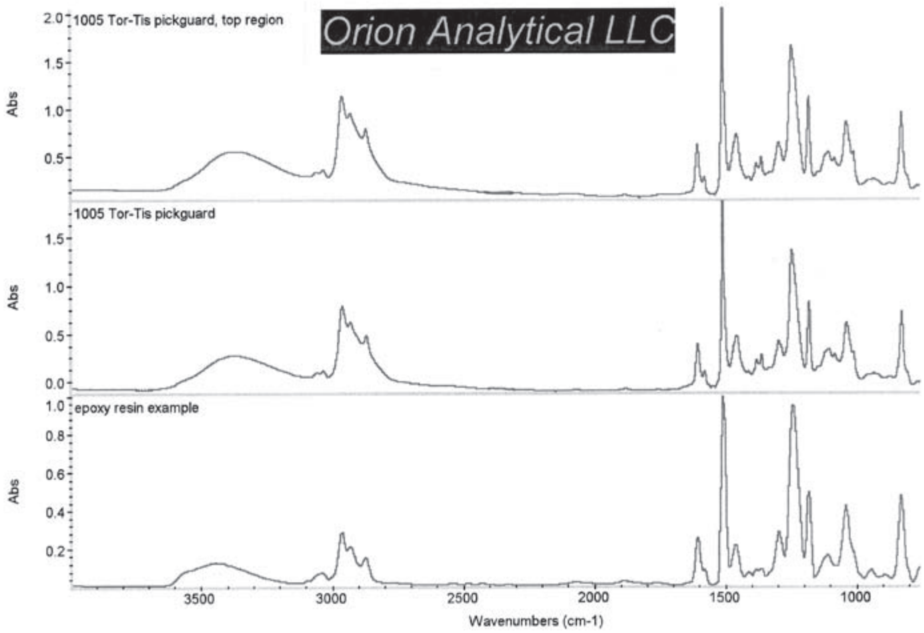

Fig. 3 **Three spectra from the FTIR analysis, showing that the unknown is identical to common epoxy. Analysis and spectra provided by James Martin and Orion Analytical LLC.**

a known sample of bisphenol-A epoxide is almost an exact match with the sample unknown. Mr. Martin's interpretation stated that most commercial epoxides are derived from a condensation reaction between epichlorohydrin and Bisphenol-A. Apparently, Turtleworks used a low-viscosity epoxy, because it is clear from the samples that the resin was cast out onto a non-stick surface, allowed to form a thin glass-like pool, and any air bubbles allowed to settle to the surface and burst. Using an epoxy would support the manufacturers claim that it is "highly refractive" and "untouched by all solvents." Turtleworks may use catalysts to accelerate the set, which in the long-term can also accelerate the aging and yellowing of an epoxy. Unfortunately, it was not possible to identify easily the orange or brown colorants within the epoxy, since the resin is insoluble in any known solvent, and the colorant is thinly dispersed within the epoxy.

Turtleworks recommends immersing the sheet in warm water and using a scissors to cut it, which works well (fig. 4). If the resin is cut with scissors at room temperature, it will crack and shatter unexpectedly. It does not seem to polish very well on a buffing wheel because as the resin warms, it softens and debris becomes ingrained in the epoxy. However, Micro-mesh abrasive pads and some elbow grease work very well. Additionally, setting pieces with fine scratches on them on a clean sheet of glass in a lab oven set at about 100° Celsius will soften and conform to the surface of the glass. After cooling, the epoxy can easily be cleaved off the glass and will have a smooth glass-like finish. Where accurate bending is desired, a Leister hot air tool works very well (fig. 5).

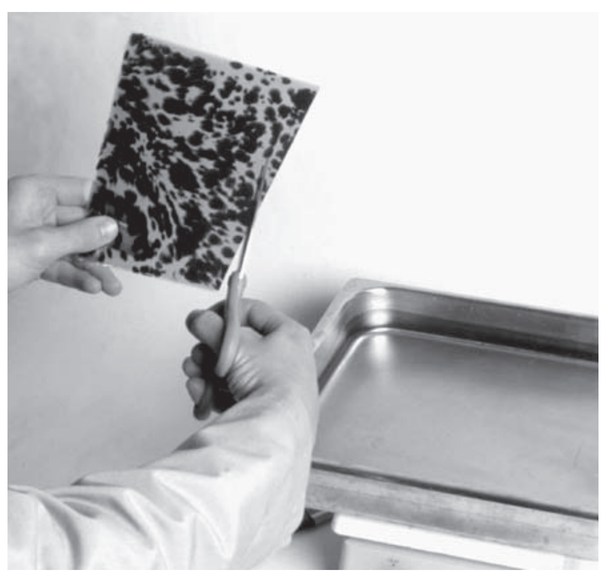

Fig. 4 **Warming the material in hot water and cutting with scissors.**

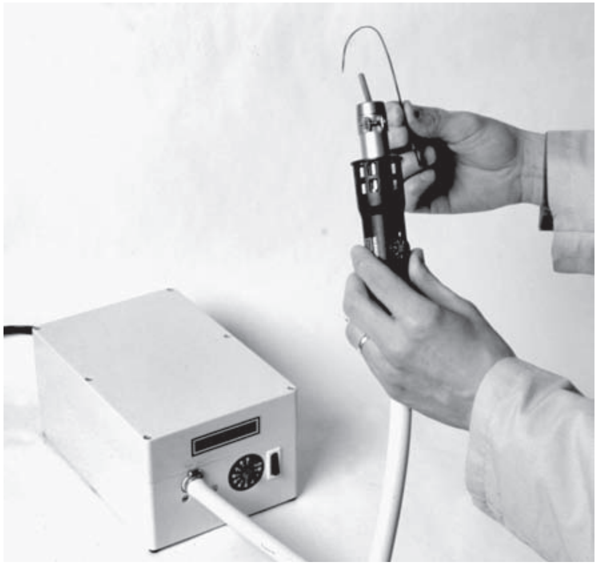

Fig. 5 **Bending the material with a Leister hot air tool.**

After the restored pieces of the fan were cut and polished, they were attached to the feathers with Jade 403, a polyvinyl acetate emulsion adhesive. Finally, all of the parts of the fan were assembled and secured together with a brass pin, flattened on each end with a ball-peen hammer. A black thread holds all of the sticks the proper distance apart when the fan is opened (fig. 6).

In summary, this material is probably appropriate to use in conservation. It would have to be set into place with an appropriate, reversible adhesive, but few long-term problems with this material can be foreseen. One possible problem is continued yellowing or darkening with age, though this should not be significant unless the exact color of the fill is critical.

Materials Sources

Luthiers Mercantile International, Inc.
P.O. Box 774, 412 Moore Lane
Healdsburg, CA 95448
707-433-1823
800-477-4437 (orders)
707-433-8802 (fax)
www.lmii.com

Micro-mesh abrasive pads
Micro Surface Finishing Products Inc.
1217 West Third Street, Box 818
Wilton, Iowa 52778
(319) 732-3240

Turtleworks, c/o Colette Hanson
2650 N. Brummetts Creek Road
Bloomington, IN 47408
(812) 334-2496

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Fig. 6 **Ladies fan after treatment. Black ostrich feathers attached to restored epoxy sticks.**