# Chemical Resistance of Cured Lacquer Film

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*An introduction to oriental lacquer was published in a previous article of this journal.*[1]

Oriental lacquer is a readily available natural product derived from the sap of the lacquer tree (*Melanorrhoea usitata*).

Lacquer has been used on such materials as wood, bamboo, metal, ceramics and stone.

Many ancient treasures coated with lacquer can be found in famous museums around the world. Most of these objects are still in good condition. Some have been subject to conservation.

Before the appropriate conservation measures are carried out, the conservators need to know not only the causes of deterioration but also the physical and chemical properties of the hardened or cured lacquer.

Although it is claimed that cured lacquer has many advantageous properties, such as being weather proof and chemical resistant, [2-3] this claim has not been supported by any scientific evidence. The objective of the present work is to investigate the chemical resistance of cured lacquer film. The results of this study will provide a guideline of useful information for conservators and restorers to use in the future.

Two commercial lacquers were obtained from a local lacquer manufacturer in Chiengmai, Thailand. A pure Burmese lacquer from the Burmese lacquer tree was collected from Mae Cham District in Chiengmai, Thailand.

A set of 18 samples of lacquer film from each lacquer type was prepared by applying approximately 0.6 gram of each lacquer sample onto a glass slide (2.54 x 7.62 cm). The thin lacquer film was allowed to dry slowly at room temperature for 35 days. After hardening, a

FIGURE 1. CURED LACQUER FILMS WERE SOAKED INTO ACIDS FOR 6 MONTHS.


FIGURE 2. CURED LACQUER FILMS WERE SOAKED INTO BASES FOR 6 MONTHS.

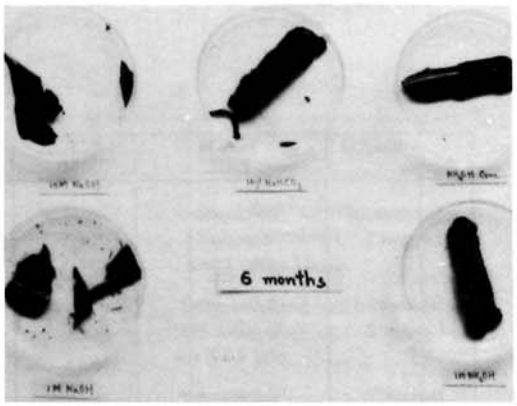



FIGURE 3. CURED LACQUER FILMS WERE SOAKED INTO NON-POLAR SOLVENTS FOR 6 MONTHS.

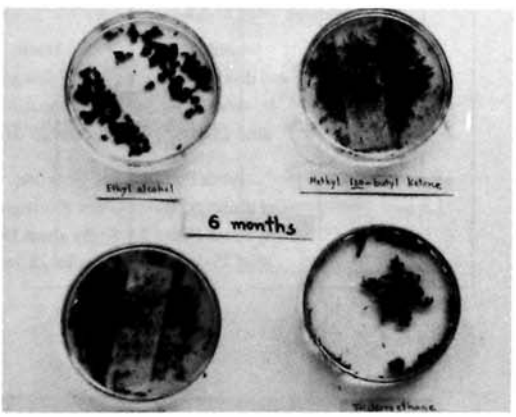


FIGURE 4. CURED LACQUER FILMS WERE SOAKED INTO POLAR SOLVENTS FOR 6 MONTHS.

## TABLE 1

## CURED LACQUER FILM IN ACIDS

| Reagent / Sample | $H_2SO_4$ Conc. | $H_2SO_4$ 1M | HCl Conc. | HCl 1M | Acetic acid glacial | Acetic acid 1M |
|---|---|---|---|---|---|---|
| Commercial Lacquer 1 | disintegrated completely after 1 hour | resistant | resistant | resistant | disintegrated by about 80% after 4 days | resistant |
| commercial Lacquer 2 | disintegrated by about 70% after 4.5 hours | resistant | resistant | resistant | disintegrated by about 80% after 4 days | resistant |
| Burmese Lacquer | disintegrated by about 50% after 2 days | resistant | resistant | resistant | disintegrated by about 40% after 6 months | resistant |

| Reagent / Sample | NaOH 10M | NaOH 1M | NaH CO 10% | $NH_4OH$ Conc. | NH OH 1M |
|---|---|---|---|---|---|
| Commercial Lacquer 1 | brittle and disintegrated by about 60% after 25 days | brittle and disintegrated by about 50% after 25 days | resistant | resistant | resistant |
| Commercial Lacquer 2 | brittle and disintegrated by about 30% after 25 days | brittle and disintegrated by about 30% after 25 days | resistant | resistant | resistant |
| Burmese Lacquer | brittle and disintegrated by about 15% after 25 days | brittle and disintegrated by about 15% after 25 days | resistant | resistant | resistant |

## TABLE 2

## CURED LACQUER FILM INBASES

## TABLE 3

## CURED LACQUER FILM IN NON-POLAR SOLVENTS

| Reagent / Sample | Hexane | Benzene | Carbon tetrachloride |
|---|---|---|---|
| Commercial Lacquer 1 | resistant | disintegrated completely after 2 hours | disintegrated completely after 2 hours |
| Commercial Lacquer 2 | disintegrated by about 30% after 4 days | disintegrated completely after 2 hours | disintegrated completely after 2 hours |
| Burmese Lacquer | resistant | disintegrated completely after 2 hours | disintegrated completely after 2 hours |

| Reagent / Sample | Ethyl alcohol | Ethyl acetate | Methyl iso-butyl ketone | Trichloroethane |
|---|---|---|---|---|
| Commercial Lacquer 1 | disintegrated by about 50% after 2 hours | disintegrated completely after 30 minutes | disintegrated completely after 30 minutes | disintegrated completely after 2 hours |
| Commercial Lacquer 2 | disintegrated by about 30% after 2 hours | disintegrated completely after 30 minutes | disintegrated completely after 2 hours | disintegrated completely after 2 hours |
| Burmese Lacquer | disintegrated by about 15% after 2 hours | disintegrated completely after 30 minutes | disintegrated completely after 2 hours | disintegrated completely after 2 hours |

## TABLE 4

## CURED LACQUER FILM IN POLAR SOLVENTS

thin cured lacquer film was produced. Each of these lacquer films, unless otherwise stated, was then soaked in a chemical reagent for 6 months. The results of the experiment are summarized in Tables 1-4.

Comparisons of the chemical resistance of the cured lacquer films from the two commercial lacquers and the Burmese lacquer were made. In the study four systems of various chemical reagents were used. These were a series of acids, bases, non-polar and polar solvents.

Table 1 summarizes the results of cured lacquer films in acidic solutions. None of the cured lacquer films survived the concentrated sulfuric acid ($H_2SO_4$ Conc.) as expected. However, the cured Burmese lacquer film showed a slight resistance to the concentrated sulphuric acid for a short period of time. Glacial acetic acid also attacked cured lacquer films but not as severely as concentrated sulphuric acid. On the other hand all three types of cured lacquer films were resistant to diluted sulphuric acid (1M $H_2SO_4$), concentrated hydrochloric acid (HCl Conc.), diluted hydrochloric acid (1M HCl), and diluted acetic acid (1M acetic acid).

The results of cured lacquer films in basic solutions are shown in Table 2. When the cured lacquer films were soaked in concentrated sodium hydroxide (10M NaOH) and diluted sodium hydroxide (1M NaOH), in both cases the cured lacquer films became brittle and disintegrated. On the other hand the cured lacquer films are resistant to 10% sodium bicarbonate ($NaHCO_3$), concentrated ammonium hydroxide ($NH_4OH$ Conc.) and diluted ammonium hydroxide (1M $NH_4OH$).

Surprisingly, the cured lacquer films deteriorated in most of the non-polar and polar solvents used in this study as shown in Tables 3-4. The solvents included benzene, carbon tetrachloride, ethyl alcohol, ethyl acetate, methyl iso-butyl ketone and trichloromethane. It was found that only hexane did not have any serious effect on cured lacquer films. This suggests that during the polymerization of lacquer under the conditions of this experiment, low molecular weight and less crosslinked polymers were formed.


## Acknowledgement

The author would like to express his thanks to Mr. Veranant Neeladanuvongs of the Northern Industrial Promotion Centre for the supply of the commercial and Burmese lacquers.


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