Reprinted from *Research and Industry*, 1972, Vol. 17, No. 3, pp. 98, 99

Adhesive Property of Lac and Modified Lac in Bonding Metal Surfaces: Part I—Optimization of Conditions for Adhesive Strength Determination

NIRANJAN PRASAD, P. K. GHOSH & T. BHOWMIK
Indian Lac Research Institute, Namkum, Ranchi

Manuscript received 18 *May* 1971; *accepted for publication* 10 *September* 1971

The adhesive strengths of three grades of shellac — *Rangeeni, Kusmi* and dewaxed shellac — on iron, brass and copper substrates have been determined under different combinations of the three main parameters involved, viz. temperature, pressure and time. Dewaxed shellac has been found to have maximum adhesion irrespective of the nature of the substrate and iron has been found to be the best surface for adhesion.

THE use of lac in the manufacture of adhesives and cementing materials is of considerable industrial importance. It has the remarkable property of adhering strongly to smooth surfaces, e.g. glass, glazed porcelain, metals, mica, etc. The behaviour of lac as an adhesive has been studied both in pure form and as a constituent of various compositions and cements[1-4]. The comparative adhesive powers of lac and lac products and other synthetic and natural adhesive materials and compositions have also been investigated. But no attempt seems to have been made towards improving the adhesion property of shellac through its chemical modification. Both the resinous constituents of lac, soft resin and hard resin, contain hydroxy acids[5-7], and their polar groups are present at the interface of the molecule. It is presumed[8] that the ability of shellac to adhere strongly to smooth surfaces is the result of orientation of these polar groups. A project has been undertaken at this institute, aimed at stuyding the relative adhesive properties of pure shellac and its compounds obtained by modifying it through its active groups. The present communication describes the results of experiments concerned with the standardization of the method of application of the adhesive and the method of determining the strength. The adhesive properties of three grades of pure shellac, viz. *Rangeeni, Kusmi* and dewaxed shellac, using three substrates, viz. iron, copper and brass, have also been determined.

Experimental procedure

Panels of iron, brass and copper (7·5×2·5 cm) having polished and glossy surfaces were used. The panels were cleaned free from oil and grease by washing with trichloroethylene.

Alcoholic solutions (10%, 0·5 ml) of different shellac samples were spread over polished and cleaned surfaces of the panels on 2·5×2·5 cm (1 sq in) area and then left overnight for drying at room temperature (20-30°C). Next day, they were baked at 94-95°C in a steam oven for 1 hr. Two panels were placed, one upon the other, overlapping the coated area (1 sq in) of one with that of the other and then hot pressed in Carver press for different time intervals at different temperatures and pressures. The bonded panels were allowed too cool overnight at room temperature and the bond strength of each pair was determined with the help of Hounsefield tensometer. Five samples were tested in each experiment and the mean values are reported. The physical characteristics of the lacs used are given in Table 1.

Results and discussion

The adhesive strengths of different samples were determined at different temperatures, pressures and time intervals. In different sets of experiments, two of these three parameters were kept constant and the third one was varied in turn. The ranges of variation of the parameters were as follows: Temperature, 100-220°C; pressure, 400-4000 lb/sq in; and period 0·5-3·5 hr. It was observed that on increasing the value of any one of the three parameters (temperature, pressure and time), keeping the other two arbitrarily constant, the bond strength of all the three grades of lac on all the three substrates first increased and then began to decrease. For iron surface, dewaxed lac had maximum bond strength at temperature 150°C, pressure 2000 lb/sq in and time 1·5 hr. For brass surface, *Rangeeni, Kusmi* and dewaxed lacs had maximum bond strength at temperature 150°C, pressure 2000 lb/sq in and time 2·5 hr. For copper surface, *Rangeeni* had maximum bond strength at the same conditions of temperature, pressure and time as for brass surface. *Kusmi* showed maximum strength on

Table 1 — Physical characteristics of lac samples

Grade of shellac	Life under heat min	Flow mm	Acid value
Rangeeni	34	8·6	63·88
Kusmi	44	10·5	66·43
Dewaxed (coloured)	22	5·7	71·39

Table 2 — Optimum combinations of temperature and pressure for maximum bond strength

(*Time* 1 *hr*)

Surface	Shellac	Temp. °C	Pressure lb/sq in
Iron	*Rangeeni*	200	400
	Kusmi	185	2000
	Dewaxed	185	400
Brass	*Rangeeni*	150	2000
	Kusmi	175	2000
	Dewaxed	175	800
Copper	*Rangeeni*	150	2000
	Kusmi	200	1600
	Dewaxed	200	2000

Table 3 — Optimum conditions of temperature, pressure and time for obtaining maximum bond strength

Surface	Lac	Maximum bond strength tons/sq in	Temp. °C	Pressure lb/sq in	Time hr
Iron	*Rangeeni*	0·320	200	400	2·5
	Kusmi	0·262	185	2000	2·5
	Dewaxed	0·350	185	400	1·0
Brass	*Rangeeni*	0·230	150	2000	2·5
	Kusmi	0·210	175	2000	2·5
	Dewaxed	0·250	175	800	1·0
Copper	*Rangeeni*	0·235	150	2000	2·3
	Kusmi	0·206	200	1600	1·5
	Dewaxed	0·240	200	2000	1·0

copper at temperature 150°C, pressure 2000 lb/sq in and time 2 hr.

It was evident from the data obtained that on iron surface *Rangeeni* has maximum bond strength at 200°C, whereas both *Kusmi* and dewaxed lac had maximum strength at 185°C, pressure and time having been kept arbitrarily constant at 2000 lb/sq in and 1 hr respectively. For brass surface, *Rangeeni* had maximum strength at 150°C, while both *Kusmi* and dewaxed lac had maximum strength at 200°C and *Rangeeni* lac at 150°C.

The next series of experiments were performed adopting the optimum temperatures determined as above and varying pressure. The time was kept arbitrarily constant at 1 hr.

The optimum combinations of temperature and pressure, for maximum bond strength (time being constant at 1 hr) for different substrates are given in Table 2.

Another series of experiments were conducted varying time and keeping temperature and pressure constant at the values given in Table 2.

The optimum values of all the three parameters worked out in this manner are given in Table 3.

It is seen from Table 3 that the bond strengths on different metals are in the following decreasing order: iron, brass and copper. The three grades of shellac arrange themselves in the following descending order in respect of bond strength obtained: dewaxed lac, *Rangeeni* and *Kusmi*.

Acknowledgement

The authors wish to thank Dr S. C. Sengupta, Director, Indian Lac Research Institute, Namkum, Ranchi, for his keen interest in the work.

References

1. McBain, J. W. & Hopkins, D. G., *J. phys. Chem., Ithaca,* **19** (1925), 188.
2. McBain, J. W. & Hopkins, D. G., *On adhesives and adhesives action,* Second Report of Adhesive Research Commission, 1926, 34-89.
3. McBain, J. W. & Lee, W. B., *J. Soc. chem. Ind., Trans.,* **46** (1927), 321.
4. McBain, J. W. & Lee, W. B., *J. phys. Chem., Ithaca,* **31** (1927), 1674.
5. Tschirch, A. & Farner, A., *Arch Pharm.,* **237** (1899), 36.
6. Verman, L. C. & Bhattacharya, R., *London Shellac Res. Bur. Tech. Paper No.* 1 (1934); *Tech. Paper No.* 5 (1935).
7. Palit, S. R., *J. Indian chem. Soc.,* **5** (1942), 25.
8. Murty, N. N., *Plastics,* **9** (1945), 585.