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Shellac as an Adhesive*

M. ISLAM, NIRANJAN PRASAD & P. K. GHOSH

Indian Lac Research Institute, Ranchi

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Shellac, due to its remarkable adhesion to smooth surfaces, high insulating and non-tacking properties, and high resistance to attack by transformer oil and petroleum type hydrocarbons, finds extensive use in adhesive formulations and electrical industry. Notable among its applications are manufacture of black insulating adhesive tapes, grinding wheels, water proof abrasive papers, dry mounting tissue papers, laminated jute and paper boards and laminated hessian boards for making tea chests.

SHELLAC has been used as a constituent of adhesives and cementing materials from early times because of its remarkable adhesion to smooth surfaces, particularly of glass, mica, glazed porcelain, polished metal, etc. On account of its excellent insulating and non-tacking properties, it finds extensive use in the electrical industry as a binder for mica in the manufacture of micanites and other insulating materials. It owes its use in several adhesives to its high resistance to attack by transformer oil and petroleum type hydrocarbons and also its remarkable property of not being adversely affected by ageing.

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Shellac has, however, certain drawbacks, viz. brittleness, low softening point and comparatively poor water resistance, which are responsible for limiting its use in adhesive formulations. Also, its bond strength for certain surfaces, though high, is not sufficient to withstand the required amounts of mechanical stress and strain. These drawbacks, however, can be rectified to a great extent by making suitable modifications in various compositions.

Laminated mica, popularly known as micanite, finds use in the manufacture of transformers and electrical dynamos, such as commutator segments, cones, v-rings, insulating barriers, slots, troughs, tubes, etc. Generally, shellac either in alcoholic solution or in powder form is used for making micanites. But in recent years a few modifications of the adhesives with improved strength and flexibility have been formulated. Micanites prepared using ethylene glycol esterified lac or hydrolyzed lac remain flexible even after prolonged heating at 150°C. Some plasticizers, e.g. tartaric acid, are also used for making flexible micanite.

Another important use of shallac adhesives in electrical industry is in the manufacture of black insulating adhesive tapes. A suitable composition for the manufacture of these tapes can be prepared by modifying shellac acids by the incorporation of semi-drying oils, such as castor oil, linseed oil, fatty acids and glycerine[2].

The excellent adhesion properties of shellac make it a particularly suitable bonding material for the production of grinding wheels. There are various types of grinding wheels, depending on the binder and abrasive materials used. Shellac wheels are particularly suitable where the material removal is slight, such as the final grinding of camshafts, hardened steel components and chilled rolls, sharpening razor blades, knives and saws. Shellac is the only satisfactory binding material for cutting wheels for marble, graphite, concrete, etc., and for grinding wheels for cast iron and steel rollers, camshafts, circular and surgical knives, etc.[3]. The grinding wheels are prepared by mixing shellac with powdered abrasive, heating the mixture in a kneading machine and allowing it to cool. The powdered mixture is reheated, worked into steel moulds and subjected to hydraulic pressure in a heated press. For curing, the wheels are embedded in sand and gradually baked over 2-3 days, the temperature being gradually raised to 175°C.

Shellac is also used for making water-proof abrasive paper. The paper, which is previously soaked in light mineral oil to make it water-proof, is coated with a suitable lac-based composition prepared by fusing garnet lac with linseed oil or castor oil fatty acids and refluxing this product in alcoholic solution with the requisite proportions of urea, formalin and maleic anhydride. The abrasive grains are next spread on it in a uniform thin layer followed by mild baking[2].

Dry mounting tissue papers, which are used for fixing photographs on mounts or hard paper boards, are prepared by coating both sides of a tissue paper with a suitable composition based on shellac. The composition is prepared by dissolving 3 parts dewaxed shellac and 1 part rosin in 6 parts denatured spirit with small quantities of a suitable plasticizer. The coated paper is dried by passing through an oven at 80-90°C and is finally trimmed to size before use for fixing photo/pictures on mounts. A pilot plant for the manufacture of dry mounting tissue paper has been designed at this institute. The process has been patented and is being exploited by some of the principal manufacturers of dry mounting tissue papers in the country[4].

Shellac-based adhesives are also used for the manufacture of laminated jute and paper boards. The composition is prepared by reacting shallac in alcoholic solution with urea formalin. Jute hessian and/or paper is impregnated with the above solution, dried and then hot pressed for making boards. Low cost water-based shellac adhesives can be prepared by mixing ammoniacal solution of lac and casein with suitable proportions of lime and aluminium stearate[5].

A cheap composition and method have been developed recently for making laminated hessian boards used for making tea chests. The hessian is soaked in 10% ammoniacal solution of kiri lac and the lac is precipitated by passing the coated hessian in a tank containing 10% sulphuric acid. It is thoroughly washed with water to make it free from acid and dried. Several such coated and dried hessian clothes are hot pressed to make laminated boards, which can be used for making tea chests[6]. Gasket shellac compound, which is generally a thick alcoholic solution of shellac containing a little toluene, is ideally suited for making petrol and gas-tight seals for engines and fuel lines widely used in the automobile and aviation industries[7]. A good water resistant adhesive for bonding glass to glass, metal to metal, etc. can be prepared by reacting hydrolyzed lac with maleic anhydride followed by esterification with allyl alcohol[8].

Thus, lac has immense potentialities in the field of adhesives. A project is in hand at this institute aimed at collecting comprehensive data regarding the adhesive strength of shellac of different varieties as such and in modified form on different metallic surface, viz. iron, copper and brass. The adhesive strength of different samples was determined at different temperatures, pressures and time intervals. On increasing the value of any one of the three parameters and 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 under the same conditions of temperature, pressure and time as for brass surface. Among the three grades of shellac, 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[9]. Plain "*bhutta*" shellac has

been modified with 0-5% polycarboxylic acids, such as tartaric acid, maleic acid and phthalic acid and the adhesive strength of the products determined. All these acids increase the bond strength of shellac from 0.1 to 0.19 ton/sq in. Among the acids tried, maleic acid gave the best results, addition of 4% maleic acid increasing the bond strength of shellac from 0.08 to 0.30 ton/sq in.

Hydrolysed lac was heated at 150°C, samples were taken out at different time intervals and the adhesive strength determined. It was observed that maximum strength of the product could be obtained on heating the hydrolysed lac for 90% of the time of polymerization. This product having adhesive strength 0.38 ton/sq in was found better than the products obtained by modification with polycarboxylic acids.

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