ELECTRIC STRENGTH OF VARNISH FILMS

IN a paper entitled "Intrinsic Electric Strength and Conductivity of Varnish Films and their Variation with Temperature" (*J. Inst. Elec. Eng.*, **89**, Pt. 1, No. 23; November 1942), A. Morris Thomas and Miss M. V. Griffith discuss recent advances in the theory of the intrinsic electric strength of solids, and describe methods for the preparation and testing of samples of baking insulating varnishes and shellac-varnish films for the determination of their intrinsic electric strength. The varnishes tested were a clear baking oil insulating varnish, a black baking bituminous insulating varnish, a synthetic-resin insulating bakelite varnish, and a pure de-waxed lemon shellac varnish.

The results of the tests made on a thickness range of 0·02–0·1 mm., and a temperature range down to −196° C., are reported. The investigation also includes conductivity measurements, effect of different ambient conditions (immersion media and applied pressure), time/voltage tests, and the effect of centrifuging and filtering and comparison tests on varnish-impregnated paper films, which were made to establish the validity of the method of test and to assist interpretation of the results.

The large and continuous increase of intrinsic electric strength with decrease of temperature down to −196° C. which is found disposes of the assumption hitherto made by some investigators that this quantity is independent of temperature. Consideration of the results in relation to the recent theory proposed by Frohlich to account for a temperature-dependence of the character obtained indicates that this theory in its present form is not applicable, but an alternative explanation is suggested.

As the results of the research, the investigators reach the following conclusions. The intrinsic electric strength of varnish films is probably independent of thickness from 0·02 mm. to about 0·1 mm. at all temperatures, except that clear varnish films show a small decrease with the thicker samples at 90° C., and at low temperatures 0·04 mm. was the maximum thickness tested. The values for all four types of varnish investigated at −196° C. lie between 8,000 and 9,000 kv./cm. and decrease approximately linearly with increase of temperature up to 0° C., the exception being clear varnish. Above about 0° C. the decrease continues at a slower rate up to 60° C., and the values then tend to increase slightly up to 90° C., except that shellac gives a sharp fall. As the rates of decrease with increase of temperature differ, the values diverge, so that at 60° C. the maximum values are approximately 4,900, 3,300, 2,600 and 2,200 kv./cm. for the bakelite, shellac, black and clear varnish films respectively. The intrinsic electric strength of the bakelite varnish films is independent of time of application of voltage within the experimental range, but the other varnishes show decreases in maintained-voltage tests, which, however, may be a consequence of local defects due to inclusions or lack of film uniformity.

Relatively large inclusions of a dielectric such as cellulose in the form of paper are found not to affect appreciably the intrinsic electric strength of varnish films. The variation of the conductivity of varnish films with temperature is apparently of a complex nature and is not of a type which enables definite conclusions to be drawn with regard to the mechanism, although the results are qualitatively understandable if it be supposed that ionic conduction occurs at high, and electronic conduction at low, temperatures. The results may be considered in relation to the theory of the breakdown of organic solids recently developed by Frohlich. If electronic conduction only is assumed, then the intrinsic electric strength of a pure paraffin consisting of long-chain crystals should increase with increase of temperature, but the introduction of polar groups into the molecules may outweigh this effect and cause a decrease. For this type of variation to occur, it is necessary that the temperature be sufficiently high to enable certain of the molecular groups to rotate, and such an effect may be recognized by an increase of dielectric constant.

The investigations of phenolformaldehyde varnish films by Hartshorn, Megson and Rushton show that an increase of dielectric constant due to dipole rotation in substances of this type does not occur until a temperature of 20° C. is attained; the dielectric constant then rises from about 3 to a value of 7·6 at 80° C. This region corresponds to that over which the intrinsic electric strength of the varnish films remains approximately constant, so that the theory in its present form is inadequate to explain the results. There remains a possibility that the change of the course of the temperature variation which occurs roughly at normal temperature may be related to the change in the conduction mechanism at about the same temperature. Reference is made to the agreement of the results with those obtained on amorphous glass. It is suggested that, with materials of the type which have a colloidal structure, a falling intrinsic electric strength/temperature characteristic may be explained by the relative ease of electronic or ionic movement along internal surfaces.

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INTUITIVE KNOWLEDGE

IN a paper on intuitive knowledge in the issue of *Mind* of October, 1942, Prof. R. I. Aaron considers the present position of the time-honoured doctrine that there are certain propositions which the human mind can know without any shadow of doubt or possibility of error. This doctrine, a legacy in European thought of the philosopher-scientist Descartes, who took the deductive reasoning in geometry as the pattern of scientific thinking and the self-evident axioms of Euclidean geometry as the foundations thereof, has come to seem less compelling now that those axioms are no longer regarded as self-evident by any educated person.

The author agrees, however, that to conclude from this that the whole notion of intuitive knowledge must be discarded would be precipitate. Those who do so, assert that any so-called piece of intuitive knowledge is either merely a statement as to how certain linguistic forms are used (for example, when I know that 'no fishes have hair' necessitates that 'no creatures with hair are fishes', I am not really knowing anything except the rule by which one English sentence can be transformed into another); or, if such knowledge goes beyond words to the real world, it can never be absolutely certain (for example, when I know that my hand is before me