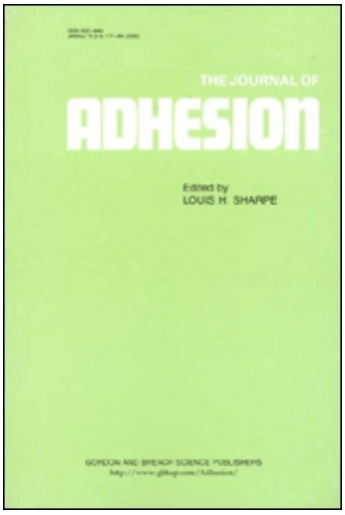

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Book Reviews

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BOOK REVIEWS

"Adhesive Bonding Techniques and Applications". Charles V. Cagle. McGraw-Hill Book Co. New York 1968. 351 pp. $16.00.

It is a pleasure to encounter a book on adhesion in English, written by one person rather than by n advocates of n different viewpoints.

The first chapter mentions, among other miscellanea, some uses of adhesives and contains an appeal for establishing a professional organization for adhesive engineers. In the second, 22 groups of adhesives are described; no chemical formula could be found in it. The third chapter deals with the application of adhesives and stresses the importance of "complete education" of the employees to whom this application is entrusted. Similar mixtures of technical and management advices are found also in many following chapters—on the design of joints, surface preparation, fabrication techniques, the testing of strength, environmental testing, quality control, the non-destructive testing (the longest chapter in the book), and on the arranging of literature files. The volume includes also a list of specifications, a list of adhesive manufacturers for the aerospace industry, and a glossary of terms used when speaking of adhesive bonds.

It would be easy to find faults with the text but this effort would be futile as the book is not supposed to be scientific and is said to be "geared primarily to the needs of the shop man, technician, or professional engineer who is not familiar with adhesive bonding". Thus, the question to be answered is—will this publication be helpful to these groups of people? In the apprentice system, the teacher instructed his pupils by deeds, by examples more than by words. In a university, professors are supposed to employ carefully defined terms. A manual for technicians may sit on the fence between the two. In the chapter on "Testing Adhesives" it is stated: "Penetration (Wetting): This may be determined by placing a measured amount of adhesive (usually, 0.020 to 0.030 g) on the top layer of a stack of 4 to 6 sheets of Whatman's No. 4 laboratory filter paper. The entire stack is then placed in a press and pressurized to 100 psi for 10 to 15 sec. The sample is then removed from the press and the filter paper examined for penetration. Only a comparison can be made of adhesives with various wetting characteristics".

If the technician has to test a hot-melt adhesive (which is solid at room temperature), or a thermosetting mixture, or a solvent cement, it is not clear what he can learn from this test. If two pieces of steel (rather than two stacks of Whatman's No. 4) have to be glued together, the test's results also will be valueless. As long as a person understands the principles of adhesion, he can apply them to any given system, but, in the absence of science, the instructions must be narrowly specific, and this is almost impossible unless the instructor stands next to the operator and closely watches his hands.

J. J. Bikerman

"Testing of Synthetic Adhesives" [Russian]. V. V. Paturoev. Lesnaya Promyshlennost Publ., Moscow 1969. 120 pp. Rub. 0.40.

Brief and simple instructions for testing adhesives popular in wood gluing are given in this booklet. The seven sections in it present (a) a description of the common adhesives (phenol-formaldehyde, resorcinol-formaldehyde, and so on), (b) methods for measuring their rheological properties (i.e., various viscosities), (c) measuring methods for the rate of setting, specific gravity, adhesiveness, contact angles, shrinkage, and heat evolution during setting, (d) determination of the "frozen" stresses, (e) testing methods for the strength of lap joints, block joints, etc., and (f) some methods of non-destructive testing.

The scientific basis of each test is explained in a few words which in several instances are misleading; for instance, equation (35) on p. 61 is valid only for infinitely small drops. However, it is interesting to read, in a pamphlet paying so little attention to the fundamentals, that "polymer particles are visible on the fracture surfaces of metal parts even though the rupture was in adhesion".

All 53 references are to Russian publications.

J. J. Bikerman

"Adhesive-mechanical Joints in Technology" [Russian]. V. N. Shavyrin, N. Kh. Andreev and A. A. Itskovich. Mashinostroyenie Publ., Moscow 1968. 232 pp. Rub. 1.01.

Two aluminum parts can be joined together with bolts, with screws, or by means of point welding, and the clearance remaining between them can then be filled with an adhesive. After the setting of the latter, a joint is obtained which, in favorable circumstances, combines the advantages of the purely mechanical and the purely adhesive fastening. This process is discussed in the book by Shavyrin et al.

The first chapter deals with the adhesives suitable for the process. Adhesives, to be useful for joining aluminum alloys, must satisfy seven requirements but those for adhesive-mechanical joining are subjected to five additional conditions. Nevertheless about 30 different adhesives, described in the original, were found satisfactory. The following chapters review (a) the technique of the point welding of aluminum and its alloys, (b) the combined procedure of point welding and gluing, (c) the strength of these combined joints, (d) the cOmbined procedure of bolting together and gluing, and (e) the procedure of screwing together and gluing.

The book is based above all on the personal experience of the authors in manufacturing plants. Only a few equations for the stress distribution are given. There are 45 literature references of which 18 are to Russian and 7 to English language publications. The book should be very interesting to those who intimately know the corresponding American technology and thus are able to compare their experience with the Russian routine.

J. J. Bikerman

"Surface Phenomena in Polymers" [Russian]. Yu. S. Lipatov, ed. Naukova Dumka publishers, Kiev 1970. 180 pp. Rub. 1.41.

The 27 papers in this little volume are divided into three groups, dealing respectively with the properties of surface layers (for instance: "Dielectric relaxation in the surface layers of polymethylmethacrylate and polystyrene"), adsorption and adhesion (e.g., "Effect of the chemistry of the filler surfaces on the adsorption of polymers") and heterogeneous polymeric materials (e.g., "Effect of the chemical modification of polymers on the resistance of structures to capillary contraction forces"). Obviously, a real review of these diverse contributions is not possible. On the other hand, since reprinting of the papers in scientific journals apparently is not contemplated, they ought to be abstracted and indexed to save them from oblivion.

J. J. Bikerman

"Aspects of Adhesion—5". D. J. Alner, ed. CRC Press, London 1969. 304 pp. $16.00.

The earlier volumes of this series each contained the proceedings of *a* conference; the present volume combines those of two conferences held, respectively, in 1967 and 1968 and (mercifully) is marketed without an increase in price. The 17 papers in it cover a wide range of subjects from the surface energy of solids to the stress distribution in single lap joints; some report new experimental and test results, and some others are reviews, critical or uncritical.

Naturally, the scientific level also varies from one to another contribution. Since it is impossible to discuss each separately, I restrict myself to pointing out two errors which have been recognized as such years ago but prove more durable than many a truth.

(1) In the paper on pp. 202-213 it is claimed that adhesion, which cannot be measured in the customary tests on adhesive joints, can be determined by scratching a solid film deposited on the surface of another solid. The scratching method has been extensively tested before and found wanting; in some instances it resulted in negative adhesion values. A treatment of the method from the dependable point of view of elementary mechanics was published by W. K. Asbeck (in the book "Adhesion and Cohesion", P. Weiss ed., 1961) but unfortunately disregarded in the work under review.

(2) The peeling tension of commercial adhesive tapes pressed against different polymeric adherends is reported on pp. 183-201. When the adherend is, for instance, cellulose triacetate, this tension is 2.4 times as great as when cellulose tristearate is employed. The author concludes that the rupture does not occur in the adhesive because this was identical in all experiments and would have given identical values for the peeling tension. Similar opinions were expressed by the earliest investigators of adhesive bonds. The obvious

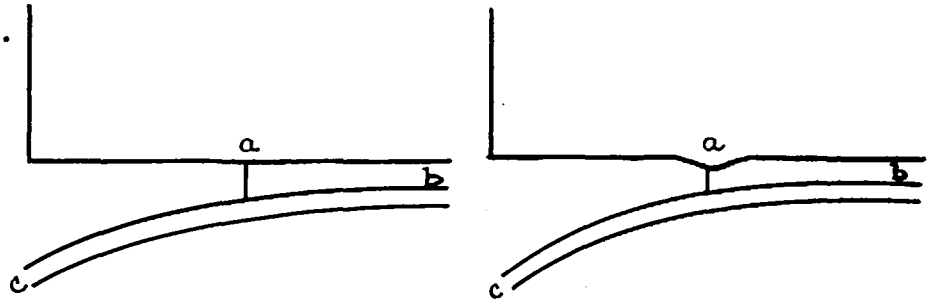

Figure 1.

error is caused by forgetting that stresses in the adhesive depend on those in the adherend. In peeling, when the adhesive layer is extended, forces are applied also to the ribbon (or the backing of the tape) and to the adherend from which the tape is being stripped. In the elementary theory (see, for instance, Bikerman, "The Science of Adhesive Joints", 1968, p. 243), this adherend is treated as a perfectly rigid solid. This assumption undoubtedly is correct as long as peeling from steel or glass is investigated. However, when the adherend is a soft polymer, its deformation during peeling cannot be neglected. An exaggerated picture of the difference between rigid and soft adherends is shown in Fig. 1; *a* is the adherend, *b* is the adhesive, and *c*, the ribbon. The adherend in the left-hand sketch is not, and that in the right-hand sketch is deformed. The experimental peeling tension must be a function of the modulus of elasticity and other mechanical constants of the adherend, and the experimental results seem to confirm this conclusion. Naturally, the presence of a weak boundary layer may also have influenced some results [for polyethylene? for poly (tetrafluoroethylene)?]

J. J. Bikerman