MINUTES OF THE MEETING OF THE OHIO SECTION OF THE AMERICAN PHYSICAL SOCIETY AT AKRON UNIVERSITY, AKRON, OHIO OCTOBER 31 AND NOVEMBER 1, 1952

THE regular fall meeting of the Ohio Section of the American Physical Society was held at the University of Akron, Akron, Ohio, on Friday and Saturday, October 31 and November 1, 1952. About 50 were in attendance. The program included trips through the Goodyear Research Laboratories and the Government Research Laboratory for Synthetic Rubber Research. Invited speakers were Dr. M. Morton of the Government Laboratories, Dr. Howard Hegbar of Goodyear Aircraft, Dr. Harry Pearlman of North American Aviation, and Mr. Walter Sturrock of General Electric Lamp Development Laboratory. The abstracts of the nine contributed papers are appended hereto.

LEON E. SMITH, *Secretary*
The Ohio Section
American Physical Society
Granville, Ohio

The Physics of Rubber.* S. D. GEHMAN, *Goodyear Tire and Rubber Company.*—This talk will include a survey of the essential characteristics of rubberlike elasticity and of present ideas concerning the molecular basis for these properties. The molecular structure consists of a cross-linked network of long chain molecules in random configurations. The retractive force is accounted for thermodynamically by the increase in entropy which occurs due to the less probable configurations which occur upon stretching. Rubberlike elasticity always occurs in a limited temperature range where the configurational forces come into proper balance with the van der Waal's forces. The contributions of physical methods of structure determination such as x-ray diffraction and infrared spectroscopy for revealing the molecular structure of rubber will be briefly discussed. Finally, there will be described a few procedures, with typical results, for physical investigations on rubber properties of technical importance such as tensile strength and modulus, low temperature stiffening, and hysteresis. In this way it is hoped to show that the physics of rubber is a field sufficiently wide to have an appeal both for physicists with research interests in understanding the nature of a fascinating class of materials and for those who are concerned in applying the principles of their science for immediate useful ends.

* This work was carried out under the sponsorship of the Office of Rubber Reserve Reconstruction Finance Corporation in connection with the Government synthetic rubber program.

Dipole Moment of β-Propiolactone. R. F. MILLER, *B. F. Goodrich Company Research Center.*—The dipole moment of β-propiolactone is 3.85 debyes at 30°C. This determination is based on measurements of 1000 cps dielectric constant of dilute solutions in benzene. The data were treated using the method of Hedestrand. Two structural forms are possible in this molecule. Calculating from my measured value of 2.01 for the related structure, trimethylene oxide, the keto form is 3.4 and the enol 0.9. Hence the dipole moment definitely indicates the keto form. This is in agreement with the bulk of chemical evidence.

A New Type of Rubber Fatigue Test. K. E. GUI, *Goodyear Tire and Rubber Company.*—One of the continuous problems confronting rubber technologists is to effect improvements in the durability of the treads and sidewalls of tires to meet increasingly severe service requirements. The evolution of these improvements can be greatly facilitated by the development of accurate laboratory testing methods so that new types of rubber and rubber compounds can be screened for durability without the necessity of building tires and of subjecting the tires to road tests. The flex testing machine to be described here was constructed in an effort to advance such laboratory evaluations. This test differs from the usual type of rubber flex test in that the sample is subjected to a constant static load, upon which the oscillating load is superimposed. The major effect of this variation in procedure is to penalize and undercured test specimen by continually stretching it out as it assumes permanent set, thus increasing the static stress. In the usual type of flex test, the permanent set taken on by the rubber during the test simply reduces the oscillating load. The conventional "constant elongation" flex test almost invariably rates the low cures of a compound better in flex life and crack growth resistance than the normal or best cures. This is contrary to service experience and makes the proper interpretation of the laboratory results very difficult.

An Extensometer for Rubber. R. P. CLIFFORD, *Goodyear Tire and Rubber Company.*—In the tensile testing of vulcanized rubber there has existed a need for an accurate, automatic method of recording the elongation of the reduced section of dumbbell type test specimens. This is especially true in connection with vertical testing machines utilizing strain gauge load weighing systems and roll chart recorders. This paper describes an experimental model of an extensometer which has proven suitable for the continuous, automatic recording of the rather large elongations normally encountered in tensile tests of cured elastomers. The extensometer was originally developed for use with the Instron tensile tester, although the principle of operation could be adapted for use with other types of testing equipment. The operation of the device is based on the differential rotation of two rollers in contact with the reduced test section of the tensile strip. The rollers are geared to synchro generators which supply an input signal to a servo loop. The output of the system is geared to the recorder chart drive mechanism which is then driven in proportion to the differential rotation of the rollers. The algebraic sum of the angular displacement of the rollers is directly related to the amount of "stretch" in the test section between the lines of contact with the rollers. The recorder strip chart therefore is driven in proportion to the true strain experienced by the length of test strip between the rollers.

Plasticizers for Polyvinyl Chloride. MARK L. DANNIS, *B. F. Goodrich Company Research Center.*—The dielectric properties of plasticized polyvinyl chloride are considered indicative of the state of the system. The high dielectric constant found at high temperatures is associated with a liquid-type behavior, the low dielectric constant found at low temperature with a solid-type behavior. The loss factor peak temperature is a demarkation point (by definition) separating these behaviors and hence is similar to the freezing point of a two-phase, two-component system. In a plasticized PVC system the demarkation point will be lowered as the concentration of plasticizer is increased. The amount of lowering also depends upon the cohesive density of the plasticizer. Conventional plasticizers fall within a narrow range of CED's, as

expected from the similarity of these polymeric systems to the similar simple systems.

The Firestone Shear Flexometer.* G. L. HALL AND F. S. CONANT, *Firestone Tire and Rubber Company.*—A shear flexometer has been developed which is capable of measuring heat build-up of elastomeric materials under either constant amplitude or isodynamic flexing (same maximum force for each cycle). The method used to maintain isodynamic flexing is to vary the amplitude automatically and while the test is in progress in response to a load cell in the cross-head member. Provisions are made for automatic ambient temperature control at either elevated or depressed temperature. Preliminary results, under constant amplitude flexing, indicate a linear relationship between temperature build-up and internal friction of the test compound and between temperature build-up and amplitude of flexure, providing the amplitude is above a certain minimum value.

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Viscoelastic Properties as Functions of the Distribution of Activation Energies. W. JAMES LYONS, *The Firestone Tire and Rubber Company.*—Assuming that in the elementary molecular deformation process the elastic and viscous strains are additive (thus conforming to the Maxwell model), and that the elastic and viscous forces are functions (of unspecified form) of the activation energy, integrals are derived for the dynamic modulus and dynamic viscosity (internal friction). The novel feature of the integrands is that they are functions of the distribution of activation energies, as well as of molecular forces and the vibration frequency. By employing an expression relating the relaxation time with the activation energy for the elementary process, and adopting the so-called "box" distribution of relaxation times, an explicit form for the distribution function for activation energies is deduced. The function involves the absolute temperature. When this function is introduced into the aforementioned integrals, the integrated results are found to predict temperature and frequency dependencies which are in gratifying agreement with experiment.

Irregularities in Radiation Along the Positive Column of a High Pressure Mercury Arc. JOHN I. FALCONER, JR., *General Electric Company.*—Variations in intensity and spectral distribution along the positive column of a high pressure mercury lamp have been observed. This effect is most pronounced in lamps in which the ratio of arc length to the arc chamber diameter is greater than 15:1. The variation in output has been shown to be due to relatively small variations in the i.d. of the arc chamber (± 2 percent or more). The diameter variation results in a variation of the ratio of the partial pressure of the starting gas to that of the mercury along the positive column. Differences in mercury partial pressures of as much as three to one have been observed in the same lamp. In general, the region of large arc chamber i.d. is the region of high output, high mercury partial pressure, and high arc temperature. The variations in intensity along the positive column increase with increasing diameter variation, decreasing ratio of mercury atoms to rare gas atoms in the lamp, increasing wattage gradient, i.e., watts/cm arc, and decreasing molecular weight of the rare gas (helium notable exception). A suitable explanation of this effect has not been obtained as yet.

Effect of a Weak Magnetic Field on a Constricted Arc in a Fluorescent Lamp. R. L. WOODHOUSE, *General Electric Company.*—The arc stream of a fluorescent lamp of large diameter may be constricted at points where particles of a foreign material are present. Under certain conditions these constrictions may be made to rotate about an axis parallel to the stream by the introduction of a magnetic field of intensity on the order of a few gauss. The frequency of rotation may be varied by motion of the source of magnetic field toward or away from the lamp. The arc stream may also be made to form a standing wave in the same manner. The position of constriction may be moved along the length of the lamp by motion of the magnetic field source in the same direction.