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THE BINGHAM MEDAL, 1955

True to its tradition, the Committee for the Bingham Medal has arrived at another fortunate selection for the 1955 medalist, in choosing Dr. Herbert Leaderman.

Known to every physicist in the field of mechanical behavior of natural and synthetic high polymers by his classical monograph on fiber deformation, by his fundamental contributions to the behavior of dielectrics in high frequency fields and especially to the construction of radar domes, and last not least for his tenacious uphill struggle for rhyme and reason in the jungles of viscoelastic nomenclature, Dr. Leaderman combines best old-world traditions with individualism, unconventionality and originality of approach in an outstanding manner.

Dr. Leaderman has been for many years at the National Bureau of Standards where he directs research on viscoelasticity. It is a happy thought that in his case the award of the Bingham Medal does not come late in a career but represents a timely recognition of past achievements and an encouragement for others to come.

THE ANNUAL FALL MEETING, 1955

This Fall, our Annual Meeting returns to New York with its large local community of Rheologists. There is one change though, as, dictated by budgetary considerations, the Meeting will be at the Henry Hudson Hotel instead of the New Yorker.

With respect to the number of papers and the corresponding difficulties which were spelled out in the preceding Bulletin, a fairly acceptable solution could be found this time, as a large number of authors agreed to having their papers held over for the joint Meeting with the American Physical Society in January. It was consequently possible to limit the number of papers to twenty as planned without alienating authors or losing papers for the Society. This solution, while not a recurring one, points a way out of the dilemma that was discussed in the last leader, "Large or Small". Very likely, two Meetings a year would be the answer to our Society's growing pains. This would admittedly involve our members in more travelling and more meeting days, but no perfect answer exists anyway to the problem of communication in a world where information grows at an exponential rate, and time for detailed discussion and personal contacts would at least be preserved. It is hoped that there will be a large attendance of our membership at this year's Annual Business Meeting, and that some clear majority opinion will crystallize which will help the Executive Committee to reformulate our Meeting Policy.

Returning to our Program for the forthcoming Events, Registration for the Meeting will begin on Wednesday, November 2 at 9:00 A.M. at the Henry Hudson Hotel, West 57th Street, New York. All lectures will be in the Tudor Room, where also the Business Meeting will take place at 4:30 P.M. on Thursday, November 3.

Dinner will be subsequently served at an hour and place still to be announced. The Social Evening and Smoker will be in the English Garden Room and Georgian Lounge.

The papers have been arranged in five Sessions, four papers each, Wednesday afternoon through Friday. The first two sessions are devoted to the Rheology of "heavy" materials, the next two to various visco-elastic properties, and the last sessions to liquids and solutions.

Below, short abstracts of the papers will be found in the order in which they will appear on the Program. As usual, the speakers will be invited to publish their contributions in the Rheology Issue, or Issues, of the J. A. P. or an additional Journal, under the auspices of the Society of Rheology. Interested authors are requested to get in touch with the Editor. It is hoped that the participation will be on the same high level as in previous years since the value of collective volumes has been generally recognized. Every effort will be made to have the Rheology Issue appear within 8-10 months from the Meeting.

ABSTRACTS OF PAPERS TO BE PRESENTED

Wednesday, November 2, 1955:
1:30 P.M.

"THE ENERGY CONTENT OF PLASTICALLY DEFORMED METALS"

MICHAEL B. BEVER, DEPT. OF METALLURGY, M. I. T., CAMBRIDGE, MASS.

Most of the energy expended in the cold working of a metal is evolved as heat during the process of deformation, but a small fraction is retained by the metal. This stored energy of cold working sheds light on the deformation process and the nature of the cold worked state; it is also the driving force for restoration processes occurring during subsequent annealing. Information gradually accumulating shows that the amount of the stored energy is a function of such variables as the deformation process, the temperature of deformation, the strain and the composition of the metal. The mechanism by which a metal stores the energy of cold work is of special current interest.

RHEOLOGY BULLETIN
F. R. EIRICH, EDITOR
The Polytechnic Institute of Brooklyn
Brooklyn 1, New York

"INFLUENCE OF INTERSTITIALS AND VACANCIES ON THE ELASTIC AND PLASTIC PROPERTIES OF METALS"

H. DIECKAMP, NORTH AMERICAN AVIATION, INC., DOWNEY, CALIFORNIA.

The mechanical property changes accompanying the presence of interstitials and vacancies may result by either of two mechanisms. The first of these being the "bulk effect" due to the presence of point defects alone in an ideal metal containing no dislocations, and the second being effects arising in a real metal due to interactions between point defects and dislocations. In attempting to separate these effects, mechanical properties of copper have been studied after cold work and after irradiation by energetic electrons. Dynamic elastic modulus and plastic deformation results will be discussed in terms of theoretically predicted effects of interstitials and vacancies, analogous dilute alloying effects, and results of other property measurements.

"SOME RESISTIVITY EFFECTS OF SHORT RANGE ORDER IN α-BRASS"

ARTHUR DAMASK, DEPARTMENT OF PHYSICS, BROOKHAVEN NATIONAL LAB., L. I., N. Y.

It is well known that the cold work induced resistance in α-brass decays in two distinct steps during an isochronal anneal, and that the high temperature step is due to the anneal of dislocations during recrystallization. The annealing kinetics of the low temperature step have been studied, and the relaxation times obtained as a function of temperature. Relaxation times have also been obtained for anneals of an increase in resistance induced by a quench of annealed brass from 320°C, and a resistance decrease induced by pile neutron irradiation at 50°C. The relaxation times obtained from these experiments all agree with those obtained by anelastic measurements and are interpreted in terms of short range order.

'TESTS WITH VARIABLE STRESS RATIOS IN THE PLASTIC RANGE"

ARIS PHILLIPS, YALE UNIVERSITY, NEW HAVEN, CONN.

In this paper we describe the results of a substantial number of combined stress tests on thin-walled tubes of aluminum 2S-O. The tubes have been subjected to combined axial tension and torsion with variable stress ratios. We find that the simple theory of plastic flow is valid with fair accuracy. Yield corners are shown to exist in some of the tests. The existence of a generalized stress-strain law is investigated. Finally, some findings on primary creep are discussed.

Thursday, November 3, 1955:
9:00 A.M.

"DEFORMATION OF THE EARTH"

JOHN HANDIN AND DAVID GRIGGS, SHELL DEVELOPMENT CO., HOUSTON, TEXAS, AND INSTITUTE OF GEOPHYSICS, UNIVERSITY OF CALIFORNIA, LOS ANGELES, CALIFORNIA.

Measurements of propagation of seismic waves and of elastic deformations resulting from tidal forces indicate that the earth has a rigidity exceeding that of steel. But gravimetric data show that most of the lithosphere is in isostatic equilibrium, and the fundamental strength of the asthenosphere at depths of the order of 100 km cannot exceed a few tens of bars. Dimensionally correct models suggest why the earth is at once rigid and weak.

The kinematics of crustal distortion is well known from the wealth of evidence of field geology, but the dynamics of rock deformation is best learned through laboratory experiments in which the important natural environmental factors of pressure, temperature, time, and hydrothermal solutions are simulated as realistically as possible.

"MAGNETOHYDRODYNAMICS AND MAGNETOGASDYNAMICS"

SHIH I. PAI, INSTITUTE FOR FLUID DYNAMICS AND APPLIED MATHEMATICS, UNIVERSITY OF MARYLAND.

The fundamental equations of magnetofluiddynamics are derived. For incompressible fluids, (magnetohydrodynamics,) first the important parameters are discussed. Then some exact solutions and the properties of the equations of magnetohydrodynamics are given. Stability of laminar flow and turbulence in magnetohydrodynamics are also briefly reviewed. Finally some magnetohydrodynamic experiments are described.

For compressible fluids, (magnetogasdynamics,) first the important parameters are discussed. Then both the waves of small amplitude, Alfven's waves in compressible fluid, and shock waves in magnetogasdynamics are reviewed.

"THEORY OF DEFORMATION OF A POROUS VISCOELASTIC ANISOTROPIC SOLID"

M. A. BIOT, SHELL DEVELOPMENT COMPANY, NEW YORK, N. Y.

Equations are established for the deformation of a viscoelastic porous solid containing a viscous fluid under the most general assumptions of anisotropy. The particular cases of transverse and complete isotropy are discussed. General solutions are also developed for the equations in the isotropic case. As an example the problem of the settlement of a loaded column is treated. The second order effect of the change of permeability with deformation is also discussed.

"FLOW PATTERNS IN GLACIER ICE"

LAWRENCE E. NIELSEN AND FRED D. STOCKTON, PLASTICS RESEARCH LABORATORY, MONSANTO CHEMICAL COMPANY, SPRINGFIELD, MASSCHUSETTS.

The mass of ice moving in a glacier varies along its length because of the accumulation of snow in its upper regions and the ablation of ice in its lower regions. This brings about variable speeds of flow and complex stream lines. This problem is treated for glaciers of special shapes using a flow relationship similar to plug flow which is an approximation to the flow law of ice. It is then possible to calculate the stream lines in the ice and several generalizations can be derived which are in agreement with the known behavior of glaciers.

1:30 P.M.

"RHEOLOGICAL STUDIES OF SYNOVIAL FLUID"

MILTON G. LEVINE AND DAVID H. KLING, BOYAR-KLING ARTHRITIS CLINIC, LOS ANGELES, CALFORNIA.

Synovial or joint fluid contains a polymer, hyaluronic acid, which is thought to act as a lubricant during joint motion. The viscosity of the fluid varies in health and disease. In order to better understand the properties of the fluid, a study of the viscosity was undertaken. A simple capillary viscometer was devised to measure anomolous viscosity. Relative and instrinsic viscosities were found to correlate with the type of arthritis. Fluids were studied from different animal species, and data was obtained concerning viscosity changes with age. Synovial fluid exihibits shear "hardening" on repeated shearing.

"HYPO-ELASTICITY"

C. TRUESDELL, GRADUATE INSTITUTE FOR MATHEMATICS AND MECHANICS, UNIVERSITY OF INDIANA.

This theory represents materials as being approximately elastic in small strains but as more complicated for larger ones. It does not assume stress-strain relations. Instead, it is defined by equations of the form

rate of stress = f(rate of deformation).

Both stress-strain relations and yield phenomena are predicted by the theory in some circumstances. These circumstances are an object of research in each problem. For various values of the available parameters, the results of the theory in special cases yield stress-strain curves and yield points which seem quite like those of some physical materials.

"STABILITY OF AN INCOMPRESSIBLE HEAVY VISCOELASTIC FLUID OF VARIABLE DENSITY"

CHAN-MOU TCHEN, NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C.

Hydrodynamic equations of motion are written for a viscoelastic fluid with arbitrary retardation function and non-Newtonian viscosity. They are applied to study the stability of an infinitesimal disturbance in the fluid supposed stratified horizontally in such a way that the density and the stream velocity are functions of the vertical coordinate only. The problem reduces to the one in eigenvalues of a fourth order differential equation, and the variational principle is applied. The special case of two uniform densities and stream velocities is studied in some detail.

"MECHANICAL BEHAVIOR OF VISCO-ELASTIC FIBERS"

F. AKUTOWICZ, AMERICAN VISCOSE CORP., CORPORATION TECHNICAL DEPARTMENT, MARCUS HOOK, PA.

The underdetermined equation

(1) $a(F,D)dF + b(F,D)dD + c(F,D)dt = O$

where $F = F(t)$, $D = D(t)$ are measures of force and deformation and t is time, has seen considerable service either as a complete stress-strain relation for visco-elastic materials or as element in a distribution of such relations. (1) is a special case of (2) $M(F, D, dF/dt, dD/dt) = O$ in which the time rates do not necessarily enter linearly. (2) can be transformed into a 1st order partial differential equation in F, D, dF/dD, dF/dt, whose characteristics represent the totality of all possible force-elongation trajectories in F, D, t space. Characteristic cones degenerate into plane fans for (1) and can be easily constructed from first principles without recourse to springs and dash pots.

Thursday, November 3, 1955:
4:30 P.M.

BUSINESS MEETING

Friday, November 4, 1955:
9:00 A.M.

"VISCOELASTIC BEHAVIOR OF POLYISOBUTYLENE UNDER CONSTANT RATES OF ELONGATION"

THOR L. SMITH, JET PROPULSION LAB., CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CALIFORNIA.

The use of stress-strain curves to characterize the linear visco-elastic properties of rubberlike materials is discussed. Tensile stress-strain curves for polyisobutylene were measured at strain rates between 10^{-1} and 10^{-4} sec.$^{-1}$ and at temperatures between —54 and 85°C. The temperature dependence of viscosity was obtained from a superposition of data measured at various temperatures. Data obtained at different temperatures and strain rates gave a composite plot of reduced stress vs. reduced strain. From the composite plot, the stress relaxation modulus was calculated over ten decades of reduced time . Considerations are given to the limitations as well as other applications of the stress-strain reduction procedure.

"AN INVESTIGATION OF THE DYNAMIC MECHANICAL PROPERTIES OF POLYMETHYL METHACRYLATE"

BRYCE MAXWELL, PRINCETON UNIVERSITY, PRINCETON, NEW JERSEY.

The dynamic mechanical properties of polymethyl methacrylate are studied over a frequency range of from 6×10^{-4} to 1.6×10^{2} cycles per second and a temperature range from —20°C to +80°C. In order to cover this frequency range with a single piece of apparatus, a modified Kimball type testing machine was developed.

The testing method is analyzed and the data taken on polymethyl methacrylate and other plastics is interpreted in terms of molecular theory. The results on polymethyl methacrylate indicate that three mechanisms of relaxation are involved in the response of the material in this frequency and temperature range.

The importance of dynamic mechanical properties to the practical engineering design of plastics components is discussed. It is suggested that three-dimensional plots of modulus or loss factor vs. frequency and temperature is the best method of describing the mechanical behavior of plastics at their use conditions.

"AN APPARATUS FOR THE MEASUREMENT OF DYNAMIC BULK MODULUS"

JOHN E. McKINNEY AND ROBERT S. MARVIN, RUBBER SECTION, NATIONAL BUREAU OF STANDARDS, WASHINGTON 25, D. C.
WASHINGTON 25, D. C.

An apparatus has been developed for the direct measurement of the real and imaginary parts of the dynamic bulk modulus of solid and liquid materials over the frequency range of 50 to 10,000 cycles per second. Piezolectric crystals serving as driver and detector, together with the sample and a confining liquid, are contained in a cavity small compared with the wavelength of sound at these frequencies. Static pressure is superposed to eliminate the effect of small air bubbles. The complex compliances of the sample, confining liquid, and the cavity are additive in this region where the compliance is pure dilatation. The dynamic compliances of several natural rubber-sulfur mixtures were obtained in a preliminary evaluation of the behavior of the apparatus.

"VISCOSITY MEASUREMENTS ON MOLTEN POLYETHYLENE"

W. PHILIPPOFF AND FREDERICK H. GASKINS, THE FRANKLIN INSTITUTE, PHILADELPHIA, PA.

Viscosity measurements on molten polyethylene using two rotational viscometers of different clearances have been made in the range of rate of shear from 10^{-4} to 10^{3} sec^{-1}. These measurements were made at a series of temperatures from 120° to 200°C. Due to the checking of the measurements at the two clearances, laminar and stationary flow is established. Measurements have been made on two samples of polyethylene and one sample of polyvinylbutyral. All the results show that the non-Newtonian behavior of these melts is qualitatively similar to the behavior of concentrated solutions of polymers. For all temperatures a definite initial viscosity could be found. The apparent energy of activation for viscous flow is well comparable to values in literature. The similar behavior of melts and polymer solutions has yet theoretically to be accounted for. The description and mode of operation of the instrument is also given.

2:00 P.M.

"VIBRATORY GYRO MASS FLOWMETER"

WILFRED ROTH, ROTH LABORATORY FOR PHYSICAL RESEARCH, HARTFORD, CONN.

If a circular conduit in which liquid flows is vibrated about an axis in the plane of the loop, a gyroscopic torque is produced about an axis normal to the axis of vibration. This torque is directly proportional to the mass flow rate of the material in the conduit. This material need not be a pure liquid, but can include multi-phase systems such as slurries, liquids with entrapped gases, solids in a gas medium, and the like. By incorporation of an electrical integrator, mass flow is automatically totalized. Open loop systems and closed loop systems employing torque feed-back will be discussed.

"DETERMINATION OF STRUCTURE IN DISPERSIONS BY VISCOMETRY"

RAYMOND R. MYERS, JOHN C. MILLER AND A. C. ZETTLEMOYER, LEHIGH UNIVERSITY.

A method for the viscometric analysis of dispersions is demonstrated and clearly defines the type of structure responsible for flow anomalies in two series of dispersions. The conclusion is reached that interparticle interaction is the chief source of anomalous flow behavior in oily dispersions of calcium carbonate and aluminum silicate.

A description of the interaction in terms of the chemistry of the solid phase and the polarity of the vehicle is given. The interpretation is presented that surface forces are capable of transmitting long range aggregative forces only by the involvement of a network of particles, rather than by deep surface orientation of adsorbed vehicle. An active, high energy, surface is believed to form reversible clusters by sharing an adsorbed vehicle molecule, while a lowering of the surface energy by organic coatings reduces the amount of interaction.

"THE GRADIENT DEPENDENCE OF THE INTRINSIC VISCOSITY"

ANTON PETERLIN, CHEMISTRY DEPARTMENT, WAYNE UNIVERSITY, DETROIT, MICHIGAN.

From sedimentation and viscosity the root mean square end-to-end distance R of the macromolecule and the apparent hydrodynamic radius a/h of the monomer unit can be obtained regardless of the actual relationship between R and the polymerization degree P. These data allow the determination of the flow inside the space occupied by the macromolecule also in the case of a non-gaussion coil. Hence, the gradient dependence of the intrinsic viscosity can be calculated. According to the treatment of Bueche, the deviations from the value at zero gradient are proportional to a power of the gradient between 1/2 and 2 in rather good agreement with the experiment. By applying the usual hydrodynamic interaction treatment, however, the viscosity increases with the gradient.

"FRACTURE IN VISCOELASTIC LIQUIDS UNDER SHEAR STRESS"

J. P. TORDELLA, E. I. DU PONT DE NEMOURS AND COMPANY, WILMINGTON, DELAWARE.

Reiner proposed that the maximum rate at which a viscoelastic liquid will flow in shear is limited by the strength of the liquid. As a result of elastic behavior, part of the strain energy is conserved in the liquid. When the amount of energy conserved exceeds the cohesive strength of the liquid, rupture or fracture of the liquid occurs. Evidence found in this study of extrusion of melted plastics through capillaries and slits showed that fracture does occur; the site of fracture is the vicinity of the die inlet; fracture results in a variety of distorted and irregular extrudate shapes; the stress at which fracture occurs is a constant which is characteristic of each plastic and varies only slightly with temperature.

"GLASS"

The growing technological interest in high strength dielectrics, in high temperature resistant glasses, and in low temperature rubbers focusses more and more attention on the "glassy" or vitreous state. Three important meetings were recently held in this field.

The first was arranged in London by the British Society of Rheology on the Relaxation and Flow in Glasses, on January 28th and was briefly reported on in "Nature" 175, 747 (1955). A further lecture was given during the Meeting on "Visco-elastic Behaviour" in New Castle on April 30th. The second large meeting was arranged in Berlin by the German Glass Technical Society in May, but only the program has so far been accessible. The Third Meeting, in August, the Gordon Research Conference on Glass was the most substantial one, reviewing our present knowledge from all over the world. Its program has been published in Science, 121, 571 (1955).

JOINT MEETING

WITH THE AMERICAN PHYSICAL SOCIETY DURING THE AMERICAN INSTITUTE OF PHYSIC'S 25TH ANNIVERSARY CELEBRATION

Members' attention is directed to the Symposium on Rheology sponsored jointly by our Society and the American Physical Society during the week of the abovementioned celebration. The date is Friday, February 3, 1956 and the meeting place, The Hotel New Yorker, New York City. A major part of the Symposium will consist of lectures which could not be included into the program of our 1955 Fall Meeting. The detailed program will appear in PHYSICS TODAY and in the Bulletin of the American Physical Society.