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JOHN DOUGLASS FERRY
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A Biographical Memoir by
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AND JOHN L. SCHRAG

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Biographical Memoir

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John D. Jerry

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PROFESSOR JOHN D. FERRY was a towering figure in polymer science—in the development of our understanding of viscoelasticity and its origins in polymer structure and associated local and long-range molecular motions. His enormous contributions to the field were such that his career was both a centerpiece and a mirror of these developments. His work was always marked by a persistent, orderly, and detailed investigation of unsolved areas: actively identifying them, developing experimental tools to investigate them, interpreting the results on phenomenological and molecular scales as appropriate, and, from this, identifying the most important areas to be pursued next.

John left polymer science with an enormous legacy of understanding of both the linear viscoelastic properties of polymeric systems and the origins of these properties in their conformations and motional dynamics. This was not just an experimental legacy developed by him and his colleagues during a nearly 60-year career but, most importantly, a conceptual legacy woven from threads drawn from across the polymer field and elegantly summarized in the three editions of his book *Viscoelastic Properties of Polymers*.² Its translation into Japanese, Russian, and Polish is a tribute to its authority.

John's Ph.D. research (under George Parks, completed in 1935) at Stanford University began at a time when the concept of polymers as giant molecules was just being accepted. For his Ph.D., Ferry sought to determine whether polyisobutylene, then a laboratory curiosity, had a glass temperature.¹ His research also included an investigation of the temperature dependence of the viscosity of polyisobutylene.¹ It was here that he first encountered the phenomenon of viscoelasticity that was to become the central tenet of his research. On trying to turn a rod immersed in a sample contained in a tube to measure its viscosity, he was astonished to find that when the rod was released it would *spin backwards*. It was also at this time that he began to develop his science philosophy, which was as follows:

1. When one has related scientific phenomena that depend on many variables, much depends on how one formulates the dependence. If one can arrange the variables suitably then some important generalizations may appear that will provide considerable insight. Thus, a researcher should set up a way of looking at the group of phenomena—a conceptual scheme—which would lead to alternating theoretical and experimental work. In addition, in the development of a science it is important to have a conceptual scheme and notation accepted by workers in the field, allowing everyone to communicate readily and to approach problems from a common general point of view.

2. When planning experiments to answer a particular question one should make experiments not just accurate enough to answer that question, but much more accurate, if possible. Then one may not only answer the original question but also discover something entirely new.

These concepts were employed repeatedly in Ferry's lab and led to many new discoveries.

Between obtaining his B.A. and Ph.D. degrees, Ferry went to the National Institute for Medical Research in London to learn how to make ultrafiltration membranes that could separate proteins according to size. This was the start

of his parallel second career: the study of proteins, an activity as unknown to the polymer community as his polymer work was unknown to the protein community. (Many years later he confessed that he was really leaping at the chance to go to Europe. When his project ended, he “spent three marvelously enjoyable and instructive months rambling about there.”)

John’s first employment after earning his Ph.D. was as a private research assistant to David Spence at the Hopkins Marine Station of Stanford University. Spence was the first recipient of the Charles Goodyear Medal, an award Ferry would receive in 1981. With Spence, he worked on the chemistry of cross-linking reactions in the curing of natural rubber.

Ferry went to Harvard University in 1937 with joint appointments as an instructor and tutor in biochemical sciences, and as a researcher in the Department of Physical Chemistry, headed by E. J. Cohn, in the Harvard Medical School. In the latter role he worked under J. L. Oncley on the dielectric properties of proteins. Here he became tremendously impressed by the elegance and power of frequency-dependent measurements, which simultaneously gave information about the energy storage (elastic) and energy loss (viscous) components of a material’s response. Ferry determined to employ similar measurements in the study of polymers.

In 1938 he was appointed a junior fellow of the Society of Fellows at Harvard. This enabled him also to pursue (still half-time) studies of his own choice, which by then had settled down to the viscoelastic properties of polymers as measured by dynamic mechanical methods. He decided that all measurements should be in shear, never tension, because of the anticipated great difficulty in accurately determining the separate contributions of shear and bulk

response. It was here, in 1941, that he invented his unique shear wave propagation apparatus, with which he took advantage of the flow birefringence of polymer solutions and gels to visualize propagating waves.³ He found the theory for shear wave propagation in a viscoelastic medium in a geology journal and got help with the optical side from Professor Mueller at MIT who was one of the world's experts on the physics of anisotropic media. This work on viscoelasticity was interrupted by World War II (though two papers appeared in 1942), but the wave machine became a mainstay in his early years at Wisconsin.

During World War II, Ferry held joint appointments at Woods Hole Oceanographic Institute and at Harvard Medical School. At Woods Hole he worked on antifouling paints for navy applications. Here he met his future wife, Barbara Norton Mott, who had just completed her degree in chemistry at Radcliffe. (Their two children, Phyllis and John M., were born in Madison, Wisconsin.) At Harvard he was attached to another E. J. Cohn project, finding uses for various plasma proteins. Large quantities of these blood components were being obtained as by-products from the large-scale fractionation of human blood to obtain blood plasma and red blood cells for clinical use by the U.S. armed forces. The unit to which John was attached was asked to find applications for fibrinogen. John, along with Peter Morrison, produced two particularly useful materials: a fibrin foam that found extensive use in the stoppage of bleeding during surgery and tooth extractions, and a highly elastic and tough fibrin film. This fibrin film became the first safe and effective surgical replacement for the dural membrane, thus making brain surgery feasible for the first time; it was used extensively to treat head wounds in the later stages of the war. A biodegradable tubular form of fibrinogen, suitable as a blood vessel replacement or scaffold was

also produced, but too late to be used during the war. (The requisite large-scale pooling of blood before fractionation made contamination of the fibrinogen products a major complication. This resulted in abandonment of these materials for medical purposes after the war. In the 1990s, means of avoiding contamination were developed, which has led to a resurgence of interest in, and clinical use of, such materials.) John and Peter also produced interesting fibrinogen-based plastics, eventually resulting in two patents. Three additional patents were issued to John and other collaborators. All patents were held up until after the war, and the last was applied for and granted even later. Thus began an aspect of his work (30 percent of his papers) that is little known to the polymer community: fibrinogen and its conversion to fibrin by polymerization.⁴

His group at Wisconsin first proposed, in 1947, the detailed mechanism for this polymerization as a stepwise lateral dimerization of the rod-like fibrin monomer units, with partial lengthwise overlapping, to give double stranded fibrils with a structure resembling a two-layer brick wall.⁵ This idea became the theoretical basis for almost all subsequent studies on fibrin polymerization and was amply corroborated by numerous multidisciplinary studies that appeared over the ensuing years. It has now become an axiom.

In 1971, after a gap of 14 years, his interest in fibrinogen-fibrin conversion resumed, and in concert with students and postdoctoral colleagues he continued to make many important contributions, always in the context of contemporary ideas. These studies included investigations of the viscoelastic properties of fibrin clots that had been covalently linked with factor XIIIa compared with those that had not been ligated, often supported by flow birefringence, light

and small-angle X-ray scattering, and electron microscopic analyses.

Even after his retirement in 1982 Ferry participated in society and group meetings on fibrin polymerization in Madison, Milwaukee (International Fibrinogen Workshop, 1988), and elsewhere (New York Academy of Sciences, 1982). In his six years of publishing after retirement, 23 of 40 papers by him and his colleagues were on fibrinogen. One important result of these studies came from his insightful connection of the previously determined mechanical properties of cross-linked fibrin with the probable positioning of ligated gamma chains in the assembled polymer. His reasoning was clearly set forth in a 1996 letter to one of us (M.W.M.), which provided a functional connection between two heretofore-unrelated fibrin properties. This notable achievement was recently chronicled in *Biophysical Chemistry* (112 [2004]:215).

Ferry continued his protein studies when he went to Wisconsin in 1946, though he was now focused on dynamic mechanical and viscosity behaviors. He continued to research proteins in separate bursts throughout his career. The materials he studied included myosin, paramyosin, and meromyosin; DNA, RNA, TMV, and sodium thymonucleate; gelatin and collagen; and poly- γ -benzyl-L-glutamate. After 1971 Ferry took advantage of new instrumentation developed in his laboratories to explore molecular stiffness variations in these materials.

When he arrived at Wisconsin and returned to his polymer work, it was a time of sorting out and trying to understand the vague outlines of viscoelastic response, especially its temperature dependence. Three research pioneers had contributed substantially to the concept of time-temperature superposition in polymers. Leaderman discussed its potential application to mechanical, dielectric, and mag-

netic relaxation experiments in 1943; Andrews and Tobolsky used empirical shifts along the log time axis to construct the first “master curves” for isothermal stress relaxation data in 1945.

In 1950 in a simple but massively powerful stroke, Ferry introduced the key and unifying principle of *reduced variables* in linear viscoelasticity and rheology. This gave the physical basis and a general mathematical form for experimental observations on time-temperature superposition. With reduced variables, any response, e.g. modulus or compliance, of bulk polymers (and in some cases, solutions) was cleanly separated into two functions: one for the response vs. reduced time (or frequency) alone and a second for the dependence of the time scale shift factor, a_T , on temperature. (He introduced the symbol a_T .) Thus for pure polymers one now had a way of examining the time or frequency dependence alone, for all types of small strain deformation—transient, dynamic and steady flow, and similarly for the temperature dependence of the time scale alone.² An earlier extension of this principle to the behavior of solutions gave a third, similar, (though approximate) general function: a_c . The study of concentration dependence was important in those days because at that time experimental techniques were so limited in their temperature and frequency ranges that definitive studies were carried out primarily on concentrated solutions. Changing the concentration in such solutions dramatically changes the time scales of chain motions, which is why this was useful even if only approximately correct.² (It isn't even approximately correct for dilute solutions.)

Ferry immediately employed the superposition principle as a practical tool by showing how the shift factor, a_T , for solutions could be readily obtained from simple steady flow viscosity measurements. Later he extended the concept to

the effect of pressure on time scales, leading to another function, a_p^2 .

Equally important, failure of time-temperature superposition in any one of the different responses points to new molecular mechanisms contributing to the response. For example, poly n-butyl methacrylate at high temperature and low frequencies had a different a_T for J'' than for J' , G' , and G'' , due to an additional dispersion centered at still lower frequencies that only J'' was sensitive to.

In the years immediately following this development, Ferry carried out extensive studies of the viscoelastic properties of well-characterized polymers to examine the influence of molecular structure. Here the choice of polymers was critical, partly because of limitations in instrumental working frequency and temperature ranges. Ferry's mass of accurate and detailed data over closely spaced temperatures provided the base for the development of the widely used Williams-Landel-Ferry equation (WLF). This equation and its molecular underpinnings were major paradigm shifts for rheology, establishing the concepts that T_g and fractional free volume are defining molecular parameters. Thus the temperature dependence of $\log a_T$ for amorphous homopolymers and nonblock copolymers, of widely different chemical structures, is remarkably similar but displaced along the temperature scale according to their glass transition temperatures, T_g . The a_T behavior can be described by a widely applicable empirical equation in $T - T_s$, where the reference temperature, T_s , lies about 50 degrees above T_g .² (It was later found by others that for noncrystallizing, nondegrading polymers, this expression could be used to estimate very long time properties, including rupture, well beyond the experimentally accessed range.)

The response of individual polymers is described by a more detailed, molecularly based analysis based on frac-

tional free volume, its temperature dependence, and T_g . Thus, the fractional free volume occupies a central position in trying to understand the molecular origins of the temperature dependence of viscoelastic response. Furthermore, T_g is a defining temperature for viscoelastic response even though it is operationally difficult to measure.

In addition, the theory behind the WLF equation showed that there is a need to understand the magnitude and time dependence of volume changes associated with any mechanical property measurement. This item stems especially from Kovac's work, initiated in Ferry's lab, on the simultaneous measurement of the time dependence of volume and properties, after a temperature jump.² The fractional free volume concept has been the underlying driver for studies of physical ageing and of the effect of high pressure on T_g and mechanical properties.

The WLF equation has had a huge and widely diverse practical impact. E. g., for polymeric solids: acoustic and vibration damping, tear, tire friction, ultimate (break) properties, diffusion (e.g. slow pheremone release) and physical ageing after molding; for solutions and melts: fabrication and molding. It has also found wide use in fabrication, molding and use properties for foodstuff and cosmetic materials.

Rouse's molecular theory, which described the viscoelastic properties of long-chain molecules in terms of chain conformational dynamics, appeared just prior to the Williams-Landel-Ferry equation. Rouse had been intrigued by Ferry's experimental results and wanted to provide a physics explanation. Ferry immediately recognized that Rouse's theory provided the molecular level framework he had been searching for. This led to many seminal contributions, including the following:

- Giving a molecular basis for both reduced variables and the explicit form observed for the relaxation spectrum's different time dependencies in the dispersion, plateau, and termination (or onset of steady flow-like behavior) zones.

- Applying the extended Rouse theory to his unique, extensive study of the glass-to-rubber transition zone employing five methacrylate esters so that the influence of chemical structure and side-chain length could be explored. This is still the most complete study ever made of the effect of a regular change in side-chain substituents on the overall response of the same backbone chain. This work showed that although the directly measured responses or properties were quite different, the relaxation spectra were essentially identical in shape although displaced in magnitude and location on the time scale. The displacements were accounted for by differences in the polymer's effective bond length (determined independently by light scattering from dilute solutions), the Rouse monomeric friction coefficient, the molecular weight between entanglements and the fractional free volume.²

- Definitive experiments that demonstrated the direct relationship between small molecule diffusion in a rubber matrix and the Rouse monomeric friction coefficient for the matrix chains. This had practical implications for such widely diverse areas as air retention in tires, controlled drug and insect pheromone release, adhesive bonding of polymers, and healing of fractures in polymers.²

- Extensive studies of the entanglement plateau region for uncrosslinked polymers. This work showed the importance of the molecular weight between entanglements, M_{en} , as the dominant parameter controlling observed viscoelastic properties in this region of response, although the effect of entanglement coupling of chains enters as well. The extent of entanglement was varied by selecting different

chemical structures (polyisobutylene, styrene-butadiene, natural rubber, and polydimethylsiloxane) or by modifying the type and extent of branching. Later, even more extensive studies of the plateau region enabled him to demonstrate that additional mechanisms can appear or disappear as temperature is changed. G' , G'' , J' , J'' , or $\tan \delta$ then will not superpose. The additional vertical and/or horizontal shifts required for superposition indicate the molecular origin of this behavior.

Subsequently, Ferry made detailed investigations of the effect of trapped entanglements in cross-linked systems. The trapped entanglement treatment developed by Langley and Ferry is probably the best, most comprehensive description of such systems to date.² Ferry then used novel, ingenious, and revealing two-network experiments: a) with chemically cross-linked systems containing *free, unattached* chains, and b) with *two networks* formed by employing a new technique of radiation cross-linking specimens prestretched at reduced temperature, and then warmed so that the initial entanglement network was in a state of extension and the cross-linked network in a state of compression. These studies enabled him to explain the uniaxial extension behavior of systems that included both permanent and transient cross-links. Investigation of trapped entanglements also led him, for the first time, to study response outside the linear range. Here he showed, for example, that the Mooney-Rivlin C_2 parameter could be attributed entirely to the entanglement network. This gave a molecular explanation for the well-known fact that C_2 increases, decreases, or remains constant as the degree of cross-linking is increased.

Two-network studies also enabled molecular interpretation of the time dependence of the effects of trapped entanglements in terms of the tube model as separate contributions of segmental motion within the tube diameter,

whole chain diffusion along the tube, and tube rearrangement itself.²

In work carried out after publication of the third edition of *Viscoelastic Properties of Polymers*, Ferry and Fitzgerald initiated a series of studies on carbon-black-filled rubbers showing that in the linear viscoelastic range, black particles formed their own associative network. Its contribution to the behavior of rubbers was then examined by Ferry in novel experiments (e.g., measuring the small strain dynamic response before, during, and after the application of a 40 percent strain for a period of time). The results showed that the black particles form an independent, separate network of their own in which a temperature jump causes a vertical shift in dynamic properties, without the timescale shift seen in the unfilled polymers, by an amount that depends on the type of black. In isothermal straining, the density of the black network junctions was decreased at step strains but then recovered rather than decreasing over time if the step was not too large.⁶

By 1967 Ferry's group had obtained extensive solution viscoelasticity data for synthetic polymers in viscous solvents, but instrumental limitations were such that high precision measurements could not be obtained on dilute to very dilute solutions, especially at higher frequencies. This severely limited molecular-level interpretations of the data. In addition, since solution viscosities had to be greater than 4 poise for instrumental reasons, this precluded studies of aqueous based biopolymer solutions.

From 1967 to 1970 his group carried out major revisions of existing apparatus, developed unique computerized high-precision data acquisition systems, and built new instruments (especially multiple-lumped resonators) that enabled very-high-precision viscoelasticity measurements for solution viscosities down to 0.02 poise at shearing frequen-

cies up to approximately 10 kHz.^{2,7,8,10} This enabled Ferry's group to obtain, on an extensive scale, high-precision data for very dilute solutions of a wide variety of synthetic and biopolymers. These measurements were sufficiently precise and covered sufficiently broad frequency ranges to provide reliable extrapolations to obtain the infinite dilution properties required for quantitative tests of the elegant (isolated molecule) statistical mechanical theories of Kirkwood, Rouse, Zimm, Tschoegl, Peterlin, and others. These results were the first to unambiguously establish that the Zimm theory (bead-spring model)—when modified to include a finite number of polymer segments, intermediate hydrodynamic interaction, and exact eigenvalues—provides astonishingly precise predictions for the global motion component of the measured viscoelastic properties for linear and regularly branched polymers (less than seven arms), and provides semiquantitative-to-quantitative predictions for comb structures and randomly branched chains as well.⁸⁻¹¹

This new characterization potential led to extensive studies exploring the influence of molecular weight, molecular weight distribution, chain flexibility, side-group size, long-chain branching, solvent quality, and charge screening (polyelectrolytes) on the observed viscoelastic properties. Polymer coil expansion obtained by either employing good solvents or inserting charges along the chain also substantially alters the observed frequency dependence. The high effective frequency range now accessible gave high-frequency viscoelastic properties showing, unexpectedly, that η' did not approach the solvent viscosity limit as was expected.^{11,12} In many solvents this high-frequency limit of η' , denoted as η'_{∞} , was later found by Stokich and others to reflect a substantially modified, strongly temperature-dependent solvating environment contribution (modified by the presence of polymer) as well as other contributions. Ferry's group also

was the first to note that fairly rigid biopolymers exhibit quite different behavior, reflecting a combination of overall rotatory and flexural motions rather than the “entropy spring” behavior of flexible (Gaussian) chains, and developed an empirical “hybrid relaxation time spectrum” to describe the observed properties.¹³ Shortly thereafter a Japanese theoretician confirmed the validity of this spectrum.

One of the principal reasons that John Ferry made such wide-ranging, powerful, and unique contributions to our understanding of the role of molecular motions in rheology was that with each move to a different area, he and his collaborators developed excellent new, high-precision instrumentation that could probe the requisite temporal and viscosity regimes.^{2,3,7,8,12,14-18} Such instrumentation was not (and to a large degree still is not) available commercially. Generally, experimental studies of chain dynamics via viscoelasticity have substantially preceded theoretical understanding, due largely to the unique and enabling instrumentation developed by Ferry and his collaborators and the resulting investigations.

His influence and impact on people who interacted with him can be gleaned from illustrative comments (personal communications to one of us [R.F.L.] made by peers and associates. K. Ninomiya, Japan Synthetic Rubber Co., once said, “His lab had the most research-conducive atmosphere I ever encountered anywhere.” Similarly, DeGennes has said (before reptation), “I was trying to find out more about polymers after hearing a Sadron lecture. I looked at lots of books to no avail. But then someone told me about Ferry’s book... And there it was!”

On the personal side,¹⁹ John is almost certainly the only American polymer scientist to have been born in Dawson in the Yukon Territory of Canada. He spent his first two years in that immediate area since his father was a civil and

mining engineer specializing in dredge mining of placer deposits. Having seen the Yukon ice breakup, he was officially a sourdough. (Perhaps his early years in that cold environment are the reason why he tended to be most interested in polymer properties well above T_g !) Most of John's childhood was spent in small mining communities in Idaho and Oregon. At age eight he had a boy's size "rocker" for processing gold-bearing gravel. (Until very late in life he remained an expert with the gold pan, employing all the correct swirling and sloshing motions while maintaining the proper tilt.) Later he helped his father survey and assay placer gold. His father often told him, and this much later influenced his science philosophy, "John, you must always be sure to extract the very last nugget from your claim."

Ferry attended a one-room school in the now ghost town of Murray, Idaho. Murray was similar to Dawson in that the family was snowed in from November until May; a trip to the doctor was an all-day affair by horse-drawn sleigh over two mountain passes. At school he completed the eight grades in four years of what he described as "somewhat uneven training." A voracious reader, while still in the first grade he was successively moved to higher-level reading classes until placed in the seventh-grade level. The next year his father held him out of school because he was so much younger than his classmates. As an adult he could not remember being taught to read at home but did remember reading extensively at age five. He noted that his mother had graduated from college, in classics, and taught Latin and German in high school, and that the family had an extensive library. During high school, John taught himself enough Latin and German to later go into advanced courses in these subjects. This fascination with language persisted throughout his life as his most extensive avocation.

John entered Stanford University at age 16, after again being held back by his father for a year, and received his A.B. degree three years later in 1932 (undergrad research with Parks). He was the first Stanford undergraduate (out of about 32,000) to achieve a straight A average. In those days Stanford's Department of Chemistry each year selected and prominently displayed on a silver cup the name of the outstanding freshman chemistry student. In 1929 John's name was posted; in 1930 it was David Packard, later of the Hewlett-Packard Co.

John loved music and began to sing in the choir as a senior in high school, continued at Stanford (both choir and Glee Club) and in London (High Gate Choral Society and Westminster Choral Society with concerts in Central Hall, Westminster, across the square from Westminster Abbey). Returning to Palo Alto, he sang in the Palo Alto Philharmonic Chorus, including the Carmel Summer Bach Festival during the year he worked in Monterey. At Harvard he joined the Bach Cantata Club. In Madison he sang in the choir of the Episcopal Church for many years. While in London he also learned to play the balalaika, as he occasionally demonstrated to his research group (while he sang in Russian) at social gatherings at the Ferry home.

Former students and associates have many fond memories of times spent at the Ferry home with John and his charming and vivacious wife, Barbara, probably best known for her elegant sculptures. The playing of games, including treasure hunts and charades, was a particular attraction. The games featured highly imaginative clues that tested, sometimes mischievously, one's breadth of knowledge.

John was equally well known and appreciated for attributes other than his scientific abilities and contributions. He always had a genuine and abiding interest in and con-

cern for all his students and collaborators. Examples of his empathy for his students' needs are shown in the following.

- When he came to the University of Wisconsin in 1946, he had students who were married veterans and were housed at a former ordinance plant 30 miles away. Their only means of transportation was by bus, with the last return run at about 5 p.m., This schedule precluded the expected lab work in the evening and night. Workarounds covering direct contact time, experimental procedures, group meetings, etc., were worked out on an individual basis.

- Howe's Point: Howe was a student who, it was mutually concluded, was not cut out for science. He did make one viscosity measurement, however, and the published paper has an asterisked point in a figure, with the comment in the legend: "This point is due to Mr. Howe." Ferry's very serious comment to his questioning coauthors was: "Well, this will be Mr. Howe's only contribution to science and it should be duly noted."

- He arranged for postdocs in his lab for both Malcolm Williams and one of us (R.F.L.) so that our wives could finish their degrees in nursing and biochemistry, respectively. He also agreed to my coming in to the lab from 3:30 to midnight so that I could care for our baby while my wife did her Ph.D. lab research work from early morning until mid afternoon. He helped Ignacio Tinoco find a postdoc in biophysics and get out early to support his wife and baby.

- In a similar vein, he did not tell one of us (J.L.S.) until *after* I had succeeded in obtaining infinite-dilution viscoelastic properties, that all of the instrumental experts he had consulted concluded that these properties definitely *would not* be obtainable.

In early 1946 John joined the faculty of the Department of Chemistry of the University of Wisconsin as an assistant professor; by 1947 he had been promoted to full professor. He served as department chair from 1959 to 1967. In 1973 he was appointed Farrington Daniels Research Professor. He was a founding member of the Rheology Research Center at Wisconsin, serving on its Executive Committee until 1984. He officially retired in 1982 but continued research until 1988, after which he continued writing scientific and historical papers until 1998. He supervised more than 50 graduate students, and more than 30 postdoctoral and foreign associates from 17 countries worked in his laboratories at Wisconsin.

Throughout his career he received many national and international awards, including membership in the National Academy of Sciences (elected, 1959), the National Academy of Engineering, and the American Academy of Arts and Sciences. Ferry was a fellow of the American Physical Society. He was honored with the Eli Lilly Award in Biological Chemistry of the American Chemical Society, the Bingham Medal of the Society of Rheology, the Kendall Award in Colloid Chemistry of the American Chemical Society, the High Polymer Physics Prize of the American Physical Society, the Colwyn Medal of the Institution of the Rubber Industry (London), the Witco Award in Polymer Chemistry of the American Chemical Society, the Technical Award of the International Institute of Synthetic Rubber Producers and the Charles Goodyear Medal of the Rubber Division of the American Chemical Society. His name is in the Rubber Hall of Fame at Akron, Ohio. Other honors conferred on him include honorary president of the 5th International Congress on Rheology (Kyoto, Japan, 1968); honorary member of the Groupe Francaise de Rheology (1972); keynote speaker and guest of honor at the New York Academy of

Sciences Symposium on the Molecular Biology of Fibrinogen (1982); cochair, Gordon Research Conference on Polymer Physics (1982) and honorary member of the Japan Society of Rheology (1983).

He aided the scientific community in various capacities, as for example, the chair of the Committee on Macromolecular Chemistry of the National Research Council, president of the Society of Rheology, joint editor of the distinguished series *Advances in Polymer Science*, and as an editorial board member for five journals.

John Ferry was an extraordinary scientist who was a patient and dedicated teacher and mentor. He was admired for his encyclopedic knowledge, his ethics and absolute integrity, his ability to bring out the best in other individuals, and his linguistic abilities. In any given generation there is an occasional person who through his intellect, imagination, and ability to communicate, makes an indelible and important contribution to knowledge in his field. John Ferry was one of those people. Those of us who knew him are privileged to have interacted with him, and all of us will remember him.

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