JOHN DOUGLASS FERRY

1912–2002

Elected in 1992

"For developing experimental and a conceptual framework for modern viscoelasticity of polymers."

BY R. BYRON BIRD AND A. JEFFREY GIACOMIN

JOHN DOUGLASS FERRY, professor in the Department of Chemistry at the University of Wisconsin-Madison from 1946 until his retirement in 1982, was both a world–renowned rheologist and a highly respected chemist who made important contributions to physical chemistry, biological chemistry, and bioengineering. He was born May 4, 1912, in Dawson, Yukon, Canada, to US citizens. His father, Douglass Ferry, worked at the time as a civil engineer for the Yukon Gold Company. His mother, Eudora Bundy Ferry, a former schoolteacher, wrote a book describing their life in the mining community, *Yukon Gold: Pioneering Days in the Canadian North.*

John Ferry's childhood was spent in small mining towns in Idaho, Washington, and Oregon. In 1932, at age 19, he graduated with an AB from Stanford University, his parents' alma mater, with a straight A record, the first in the history of the institution. After two years of graduate study and research on ultrafiltration of proteins in London at the National Institute for Medical Research, he returned to Stanford to complete his PhD in 1935 in chemistry.

John then worked with D. Spence, a rubber chemist, on vulcanization accelerators. For the next ten years he held a series of positions at Harvard University and nearby: instructor in biochemical sciences; member of the Society of

Fellows; research associate in the Harvard Medical School; researcher at the Woods Hole Oceanographic Institution (developing antifouling paints for the US Navy during World War II); and member of the E.J. Cohn group, working on large-scale fractionation of human blood plasma to obtain serum albumin and other plasma proteins for clinical use by the US Armed Forces. This latter work began a career-long interest in fibrinogen and fibrin as well as the general problem of blood coagulation. With colleague Peter Morrison he developed several new products, including a fibrin film that was the first safe and effective surgical replacement for the dural membrane, thereby facilitating brain surgery.

After this decade of involvement in diverse research topics in several fields, John accepted a position in the Department of Chemistry at the University of Wisconsin–Madison in 1946, where he decided to focus on the rheology of polymeric fluids and the relation of these properties to molecular structure and molecular motion. Together with his graduate students T.L. Smith, R.S. Marvin, J.N. Ashworth, W.M. Sawyer Jr., E.R. Fitzgerald, D.J. Plazek, M.H. Birnboim, and others, John was the first to develop sophisticated equipment to measure the real and imaginary components of complex viscosity, $\eta^* = \eta' - i\eta''$, from oscillatory experiments. He and his PhD student Thor Smith may well have been the first to measure both components.

John's well-defined experimental program produced data on a wide variety of polymeric materials, illuminating many aspects of the physics of these materials. His results were written up in his groundbreaking monograph *Viscoelastic Properties of Polymers*, 1st edition (1961), 2nd edition (1970), 3rd edition (1980), published by John Wiley & Sons. In each succeeding edition, he added material reflecting the accomplishments of the rheological community during the preceding decade.

John Ferry's work on the temperature dependence of viscoelastic properties, and specifically his discovery of the shift factor $a_{T,}$ had an enormous impact on polymer engineering. The famous Williams-Landel-Ferry (WLF) equation, $\log_{10} a_T = -17.44(T - T_g)/(51.6^\circ K + T - T_g)$, where T_g is the glass transition temperature, allowed engineers to extrapolate rheological properties over a wide range of temperatures [M.L. Williams, R.F. Landel, and J.D. Ferry, *J. Amer. Chem. Soc*. 77:3701-3707 (1955)]. This eliminated the need for tedious rheological measurements at many temperatures.

Ferry's team perfected the measurement of complex viscosity, and this work spawned an industry of commercial rheometers for doing the same. But the eventual impact of Ferry's rheometry on polymer engineering awaited the fortuitous development of the Cox-Merz rule (1958). This rule, that the magnitude of the complex viscosity versus angular frequency matches the steady shear viscosity versus shear rate, $|\eta^*(\omega)| = \eta(\dot{\gamma})|_{\dot{\gamma}=\omega}$, suddenly made complex viscosity indispensable for the design of polymer processing operations, which depend on $\eta(\dot{\gamma})$. Whereas $\eta^*(\omega)$ was easily measured, $\eta(\dot{\gamma})$ required (and still does) an undue amount of experimentation.

By publishing accurate and precise measurements of complex viscosity, Ferry's team enabled and motivated others to relate rheological properties to the molecular structure of polymers. Ferry's measurements, for example, inspired Prince E. Rouse in 1953 to use a freely jointed chain of beads and Hookean springs to model polymers in dilute solution. Rouse's work was the springboard for further structure-property developments that continue to this day, enabling polymer engineers to adjust their polymer manufacturing operations by changing the polymer's molecular structure.

Because of his organizational skills and his straightforward manner, John was elected by his colleagues to chair the University of Wisconsin Department of Chemistry from 1959 to 1967. In 1968, he was a founding member of the University's Rheology Research Center, in which he played an active role well beyond his retirement. In addition, he was president of the Society of Rheology (1961–1963), and in 1961 hosted the Society for its annual meeting. He also chaired the National Research Council Committee on Macromolecular Chemistry from 1958 to 1962, served on the Visiting Commitee for the Department of Chemistry at Harvard University from 1975 to

1981, and was joint editor of *Advances in Polymer Science* from 1958 to 1986.

In addition, John held visiting appointments at institutions in Brussels, London, Grenoble, Strasbourg, and Kyoto. His sojourns in France, Belgium, and Japan were opportunities for him to further his hobby of foreign language study, a pastime that engaged him since his youth. As a boy, he had taught himself enough Latin and German to go directly into advanced classes.

His scientific contributions were recognized by many awards, including five from the American Chemical Society: the Eli Lilly Award in Biological Chemistry, the Kendall Award in Colloid Chemistry, the Witco Award in Polymer Chemistry, the Charles Goodyear Medal, and the Division of Polymer Chemistry Award. He also received the Bingham Medal of the Society of Rheology (for his contributions to knowledge of the rheology of polymeric systems, particularly in the field of periodic stresses), the Colwyn Medal of the Institution of the Rubber Industry (UK), and the Technical Award of the International Institute of Synthetic Rubber Producers. In addition, he was named an honorary member of the Groupe Français de Rhéologie and the Japanese Society of Rheology. His research accomplishments were recognized by his election to the National Academy of Sciences, the American Academy of Arts and Sciences, and the National Academy of Engineering (the latter in 1992).

John passed away on October 18, 2002, in Madison after an extremely productive career and a life of professional leadership and teaching. In addition to his treatise on viscoelasticity, he was author or coauthor of more than 350 research publications, about 30 percent of them on fibrinogen and fibrin. He supervised more than 60 PhD and MS students and about 30 postdoctoral fellows, many from foreign countries. It is fitting that we close with a quote from the memorial resolution prepared by his colleagues at the University of Wisconsin, who knew him well and appreciated his personal qualities:

John Ferry was equally well known and appreciated for attributes other than his scientific abilities and contributions. He was a true gentleman, a dedicated teacher, and mentor who always had a genuine and abiding interest in and concern for all of his former students and collaborators. His gentle, patient, and quiet personality had an effect on all who were privileged to know and work with him. His reputation for absolute integrity and his uncanny ability to emphasize and encourage the best in others are attributes to which we all should aspire. Former students and colleagues have many fond memories of times spent at the Ferry home with John and his charming and vivacious wife, Barbara [Norton Mott], a former chemist [Radcliffe 1942] turned artist.

Additional Biographical Information:

R.F. Doolittle, *Biophysical Chemistry* 112:177–180 (2004).

H. Eisenberg, *Biophysical Chemistry* 112:229–231 (2004).

J.S. Finlayson, *Biophysical Chemistry* 112:153–154 (2004).

R.R. Hantgan, *Biophysical Chemistry* 112:293 (2004).

R.F. Landel, *J. Polymer Sci.: Polymer Physics Ed.* 21:i–v (January 1983).

R.F. Landel, M.W. Mosesson, and J.L. Schrag, National Academy of Sciences Biographical Memoirs 90:86–105 (2007).

M.W. Mosesson, *Biophysical Chemistry* 112:91–93, 215–218 (2004).

J.L. Schrag, *Rubber Chemistry and Technology* 54:G72–G75 (March–April 1981).

J.L. Schrag and R. F. Landel, *Rheologica Acta* 36:205–208 (1997).

L. Smail, "Oral History Program Interview with John Ferry," [sound recording, transcript (100 pp.)], University of Wisconsin–Madison (1985).

I. Tinoco, *Biophysical Chemistry* 112:105–108 (2004).

N.W. Tschoegl, *Macromolecules* 20:909–910 (1987).