Anthony Kelly

ANTHONY KELLY

1929–2014

Elected in 1986

"For pioneering research in the development of strong solids and composite materials."

BY ARCHIE HOWIE
SUBMITTED BY THE NAE HOME SECRETARY

ANTHONY KELLY, a seminal figure in the development of composite materials and a reforming vice chancellor at the University of Surrey, died on June 3, 2014, at the age of 85.

Tony, as he was generally known, was born in Hillingdon, West London, on January 25, 1929. His father, Group Captain Vincent Gerald French Kelly, who was of Irish descent, taught mathematics to pilots in the education service of the Royal Air Force. Tony's scientific promise became apparent at the age of 13 in Presentation College, Reading, when he successfully corrected a physics teacher's work on the blackboard. Since Presentation College did not have a sixth form, he had to develop his own habit for intensive study and teach himself enough physics, chemistry, geography, and geology to take the University Intermediate Examination and win an open scholarship in science at the University of Reading.

Tony's doctoral research was carried out between 1950 and 1953 at the Cavendish Laboratory, Cambridge, in Sir Lawrence Bragg's famous crystallography group. Although his formal supervisor was W.H. Taylor and he had intermittent guidance from Bragg, his main mentor was Peter Hirsch, who had been largely responsible for setting up the x-ray microbeam equipment and exploring its use to investigate the structure of deformed metals. Bragg had realized that a sufficiently small x-ray beam might illuminate only a few of the subgrains in the mosaic structure of a deformed metal so that instead of the usual diffuse diffraction rings, spotty rings would result, giving information about subgrain sizes, their orientations, and strains. Tony admired Bragg's philosophy more generally, feeling that in later years this aspect of the great man's achievement with its emphasis on experimental data and astute simulation of dislocation behavior with bubble rafts was seriously underrated by comparison with his supervision of the research on DNA and other biomolecules.

Three significant advances came out of Tony's own work. First, he moved from x-ray reflection to transmission with thin samples with about ten times less exposure time. Second, the thin samples could then be deformed in controlled tensile tests at a known stress rather than by rolling. Third, to improve the spatial resolution of the diffraction method, he switched, in joint work with Peter Hirsch and Jim Menter, to the use of transmission electron diffraction. With hindsight it can be seen that these were crucial steps toward the successful electron microscope imaging of dislocations in thin crystals that took place in Cambridge just three years after Tony left.

The next few years were spent shuttling between the UK and the US. Tony spent one year at the University of Illinois, then a year with Alan Cottrell in Birmingham, followed by three years as a founding member (assistant then associate professor) with Morris Fine in the new Department of Materials Science at Northwestern University. Although his own research continued to focus on x-ray diffraction and deformation of metals, this experience broadened Tony's outlook so that he was invited by Cottrell to join him in Cambridge teaching a course in ceramics.

The years 1959–1967 were probably the most productive period of Tony's research career. He caught up very swiftly with electron microscopy, using it to study both deformation-induced and radiation-induced defects in magnesium oxide and graphite. With Robin Nicholson he wrote an enormously influential review of dispersion hardening of metal alloys. This was perhaps the first clear demonstration of his remarkable ability to digest and systematize an immense amount of data. On the more theoretical side, with his research student W.R. Tyson and Cottrell he investigated the conditions for a crystal to fail by pure fracture. Their approach involved not just the elastic properties but also the surface energy relevant in crack formation and so for many years this was a useful intermediate between the simplest theory depending only on Poisson's ratio and vastly more complex atomic simulations of cracks and defects.

A still more influential result emerging as a fusion of these interests was Tony's work on the deformation and mechanical properties of composites. With Tyson he investigated the behavior of brittle tungsten wires in a plastic copper matrix. Their discovery of the fiber pullout failure process provided the first explanation of an important deformation mechanism and the source of large work of fracture and hence toughness. The experimental data and their analysis also showed that at sufficient volume fraction the fibers could produce a significant increase in strength. With another research student, George Cooper, a second failure mechanism was then discovered for composites with a brittle matrix having a fracture strain less than the fibers. This proved to be the first manifestation of the multiple-fracture phenomenon later investigated in more detail by Tony and his team at the National Physical Laboratory (NPL).

With all this research activity, Tony remarkably found time to produce a couple of important books. *Strong Solids* (Clarendon Press, 1973) provided comprehensive analysis of the strength of a whole variety of crystals both perfect and imperfect together with the first analysis of composite mechanical properties and production methods. In *Crystallography and Crystal Defects* (with Geoffrey Groves; Addison Wesley, 1970), he brilliantly addressed a problem that he had noticed as a research student—the remarkable gulf between the crystallography used in structure determination of perfect crystals and the rudimentary understanding of most scientists studying the crystal defects. Both of these books have gone through several editions.

Tony moved in 1967 to NPL first as superintendent of the Materials Division and then as deputy director. The NPL not only had more extensive facilities for composite fabrication but also provided a better interface to defense institutions and industry for him to disseminate his ideas about composites and get closer to active development programs. With the team he built up there the most significant accomplishment was an in-depth investigation of the multiple-fracture mechanism and its role in the properties of fiber-strengthened ceramics, particularly concrete. He got still closer to industry when seconded for two years to Imperial Chemical Industries as part of a government-academia-industry task force.

In 1975 Tony was appointed vice chancellor (effectively CEO) of the University of Surrey—the previous Battersea Polytechnic which had just moved to a new site in Guildford. Almost immediately he had to face up to very severe financial cuts which required drastic economies. He persevered, however, in building up the research activity in the new institution and campaigned most vigorously on its behalf. At a meeting of vice chancellors in Downing Street he was apparently told by Margaret Thatcher, "You can have money for a readership, Dr. Kelly, but not for a professorship—like it or lump it." Against these odds he succeeded brilliantly, leading the way in the UK for universities to get a larger share of their income from nongovernment sources. His most spectacular achievement was to create a Research Park at the University of Surrey and furthermore to keep its development in-house so that it is now a major resource for the university. Although he ruffled a few feathers, the University of Surrey had become one of the two most successful of the former Polytechnics in the UK by the time he retired in 1995. Equally remarkably, Tony was able to maintain his research activity during these 18 years of heavy administration. The flow of publications that emerged from the vice chancellor's office included not only works of scholarship such as encyclopedias, where he was contributor as well as editor, but also reports of his continuing efforts to explain composite behavior in terms of the geometry and properties of the constituents. There was even some experimental work on the packing of fibers using raw spaghetti! Sailing became his major means of relaxation in these years.

In retirement Tony moved back to Cambridge, renewing his connection with Churchill College where he had been a founding fellow in 1960. The college became even more important to him after the death of his wife Christina whom he had first met as a student in Reading. Tony's style could switch between emollient and abrasive and she was adept at dealing with this. Later on he suffered from arthritis and was able to get direct experience of our success in mimicking nature with hip and knee joints. Despite all this his energy and sense of humor did not desert him. Distrusting some of the forecasts of climate change he got the support of 40 of its fellows to send a petition to the Royal Society persuading it to make some changes in its public stance. Most of all he strove to keep open the window that he had created between academic research and composite technology.

Tony held the UK national honors of Commander of the Order of the British Empire (1988) and Deputy Lieutenant, Surrey (1993). He was a fellow of the Royal Society and its Bakerian Lecturer (1995), a fellow of the Royal Academy of Engineering and winner of its President's Medal (2011), president of the Institute of Materials, Mining and Metallurgy, and an honorary fellow of the Institute of Linguistics; he held honorary degrees from the Universities of Surrey, Birmingham, Reading, Hanyang (S. Korea), and Navarra (Spain). In the UK he served as both member and chairman of the Engineering Requirements Board and of the Joint Standing Committee on Structural Safety of the Institutions of Civil and Structural Engineers.

Tony's enthusiasm and endurance were widely admired as were his magnificent hospitality and munificence. As a devout Catholic throughout his life he supported many good causes and was made a Papal Knight. He leaves behind four children—Marie-Clare, Paul, Andrew, and Steve—together with seven grandchildren.