RAYMOND E. SMALLMAN

1929–2015

Elected in 2005

"For fundamental studies of defects in solids produced by irradiation damage and plastic deformation."

SUBMITTED BY THE NAE HOME SECRETARY

RAYMOND EDWARD SMALLMAN passed away February 25, 2015, at age 85.

He was born in Wolverhampton on August 4, 1929. The middle child of a family of five siblings, with two brothers and two sisters, he was certainly not born with the proverbial silver spoon in his mouth, not even mild steel!

He lived most of his early life near Cannock in Staffordshire and, throughout the hard times of the 1930s and then the war years, helped in the family fish and chip shop and general store. With his father away in the Royal Air Force, the running of the shop depended on the collective efforts of the remainder of the family. For Ray, this meant rising early to collect fish and produce at the local railway station before going to school, followed in the evenings by taking orders and peeling potatoes. Inevitably, school work was a lower priority than the survival of the shop, but Ray derived great strength of character from his mother who, as a 5-year-old, had received 80 percent burns in a near-fatal bonfire accident. She was a remarkable woman with little formal education but a tremendous sense of determination.

Prepared by Professor Rex Harris, University of Birmingham. Adapted from the online posting at http://www.birmingham.ac.uk/university/colleges/eps/news/schools/Professor-Ray-Smallman-Obituary.aspx.

Despite—or perhaps because of—the challenges, Ray won a scholarship to Rugeley Grammar School (1939–47). He went on to the University of Birmingham, where he joined hundreds of returning servicemen. This proved to be a very positive factor as he was influenced greatly by their mature and enthusiastic attitude to learning.

During this time, Ray met and fell for a very attractive local girl, Doreen Faulkner, and this was the beginning of a partnership that lasted over 62 years. They were married September 6, 1952.

In the autumn of 1947 Ray began his long and distinguished association with the University of Birmingham. He entered the then Department of Metallurgy, which was under the leadership of Daniel Hanson, and Ray was taught by and exposed to such metallurgical luminaries as G.V. Raynor, Frank Nabarro, Bruce Bilby, Tsun Ko, Jock Eshelby, and of course Alan Cottrell (later to become Sir Alan). Ray drank up all these influences and in 1950 graduated with first-class honors in theoretical and structural metallurgy. He then stayed on to do a PhD on the structure of cold worked metals under the joint supervision of Cottrell and Kingsley Williamson. His PhD thesis, "An Investigation into the Crystal Structure of Cold Worked Metals," was published in 1953, the same year he coauthored two papers for publication in the very first edition of *Acta Metallurgica*.[1]

In 1953 Ray left Birmingham to join the Metallurgy Division at AERE (Atomic Energy Research Establishment) Harwell. These were the heady days of the relatively new field of nuclear metallurgy, with the added factor of irradiation damage. He worked initially on the properties of liquid metals and then on crystallographic aspects of the plastic deformation of metals.

In addition to scientific milestones, Ray's time at Harwell was personally memorable for the birth of daughter Lesley-Ann in Abingdon in August 1955.

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[1] Smallman RE, Williamson GK, Ardley G. 1953. Yield points in aluminium alloy single crystals. *Acta Metallurgica* 1(2):126–30.
Williamson GK, Smallman RE. 1953. The growth of strain-anneal crystals of pre-determined orientation. *Acta Metallurgica* 1(5):487–91.

In 1956 he was appointed section leader in the Basic Irradiated Group under the direction of Cottrell, who had now joined Harwell and eventually directed Ray into the field of electron microscopy, which became an important part of his scientific life. The main drive at this time was to establish the precise structure of irradiated solids, and it marked the beginning of a long and fruitful association between Ray and Ken Westmacott, who began his professional life as an experimental officer at Harwell. Their close friendship endured until Ken died in 2014.

Ken and Ray built a small-angle x-ray scattering camera, and their results indicated defect clusters some tens of nanometers in size in the irradiated material. They were very excited about these results and discussed them with Cottrell, who characteristically observed that "seeing is believing" and that such defects should be observable in an electron microscope. At that time in the United Kingdom, only Mike Whelan and Peter Hirsch (later Sir Peter) at Cambridge were using the electron microscope for metallurgical-type observations.

In 1958 Ray left Harwell to accept an appointment as lecturer in Birmingham's Department of Physical Metallurgy, which was then under the leadership of G.V. Raynor (the old department had split into Physical and Industrial Metallurgy, the latter under the leadership of E.C. Rollason). He proceeded to build a world-class research team to investigate the fundamental behavior of atomic-scale defects in metals and ceramics. A vital tool for these studies was an electron microscope, not, as mentioned, a standard piece of kit in those days. Cottrell, as chair of the Metallurgy Committee of the Department of Scientific and Industrial Research, was instrumental in Ray's acquiring Birmingham's very first electron microscope: Ray submitted a research proposal for a transmission electron microscope (TEM) and, in 1959, was awarded the princely sum of £11,000 to purchase an EM6G microscope.

In the classroom Ray put a lot of effort into his lectures and quickly became one of the most popular lecturers in the department. His research students in those pioneering times included Ken Ashbee, Trevor Lindley, John Terry, Jeff Edington,

Brian Beeston, and Tony Ball. It was a different world then and a lot was expected of the postgraduate students. For example, much of the ancillary equipment was designed and built in-house, employing the magnificent skills of the departmental workshop staff, and the students were involved not only in these activities but also in building partitions, covering bench tops, painting walls, and even helping to construct a hardboard box that was proudly christened the electron microscope laboratory.

At the time there were no purpose-built laboratories and the physical metallurgy research laboratories were quite close to the Physics Department. Stray magnetic fields emanating from the physics synchrotron proved to be a particular problem. When in operation, the machine produced a magnetic pulse every 9 seconds—the researchers in metallurgy were often reduced to taking pictures on the electron microscope between these magnetic pulses.

Those early years at Birmingham proved to be fruitful both scientifically and personally, as Ray and Doreen's second child, Robert, was born in 1959.

A visit to Ray's office at any time demonstrated how well organized he was (a source of some envy to those of us whose lives are largely chaotic). Among his many activities and responsibilities he found time to write his classic *Modern Physical Metallurgy*, the first edition of which appeared in 1962 (the eighth edition was published in 2013).

His productivity over some 50 years was quite remarkable, with the supervision (solely or jointly) of more than 100 PhD students, many of them staying in academia (25 became professors) and others occupying senior technical positions throughout the world. With his colleagues and students he published more than 300 research papers and, in addition to his classic tome, several seminal texts.

In 1963 Ray was promoted to senior lecturer and in 1964, at just 35, he was appointed to a personal chair in physical metallurgy. The 1960s were enjoyable and fun years for him as he focused on his research and teaching. In his research, defects, particularly vacancies and dislocation loops, were a

major theme, but he also collaborated with the alloy chemistry and rolling texture groups in his work on intermetallics and on stacking fault energy.

Ray's history is very much that of metallurgy at the University of Birmingham. In 1965 physical metallurgy moved to first-class teaching and research facilities that resulted from discussions among Raynor, Alan McQuillan, Ray, and the other members of staff. For more than 40 years the facilities coped well with the demands, a tribute to the foresight of those early, democratic discussions.

In 1966 Mike Loretto joined the department, an appointment that underpinned the department's TEM activities and ensured that they would continue to evolve and explore new territories while Ray became more involved in administrative and strategic matters in both the department and the wider university.

In 1969, when Raynor became vice principal (VP), Ray was appointed Feeney Professor of Metallurgy and head of the Department of Physical Metallurgy and Science of Materials. In 1971 he assumed the newly formed chairmanship of the School of Metallurgy, comprising the Departments of Physical Metallurgy and Industrial Metallurgy.

He was aware of the vulnerability of metallurgy at Birmingham—in terms of student numbers, it was a minnow in the large science and engineering faculty pool. This fear appeared to be justified by the disappearance of the UK's second-oldest Metallurgy Department, at nearby Aston, and the subsequent demise of its Departments of Minerals Engineering and Production Engineering. The fact that Birmingham's School of Metallurgy and Materials is still alive and well owes much to Ray's strategic acumen during those critical years.

Throughout the 1970s he pursued a strategy of strengthening the department by ensuring strong representation on universitywide bodies, in his role as chair of the Engineering Group of Departments and then as deputy dean of the Faculty of Science and Engineering. He always made sure that Metallurgy and Materials was well informed and well supported (this was not always popular with his colleagues in other departments).

Parallel activities on a national scale in 1970–71 resulted in Birmingham becoming a National Centre for Electron Microscopy with the introduction of the AEI EM7 1MV microscope, one of three funded by the government to further structural research in the UK. This exciting development allowed observation of in situ studies of deformation, annealing, and recrystallization, transformations at low temperatures, and irradiation damage in various structural materials. The facility provided a considerable stimulus to the department's TEM research activities, especially those involving plastic deformation, environmental cell oxidation, and high-energy electron-induced radiation damage in a variety of materials.

In 1981 one of Ray's long-term objectives was achieved with the unification of the two departments with the Centre for Materials Science to form the new Department of Metallurgy and Materials. In 1984, while still head of school, he was elected dean of the Faculty of Science and Engineering, and in 1985 he was elected the first dean of the newly created Faculty of Engineering.

In 1987 he relinquished his deanship to become the university's VP (essentially deputy vice chancellor), and a year later he relinquished the headship and Mike Loretto became department head. Ray was assisted by a very good working relationship with the vice chancellor, Michael (later Sir Michael) Thompson, and assembled a formidable team that was responsible for a number of fundamental and far-reaching changes to the university structure.

An essential part of Ray's approach was to bolster both the strong interactions between science and engineering as equal partners and the status of engineering at the university—he always made sure that the voice of engineering was heard in what were often predominantly science-based bodies. One of his legacies as vice principal was the strengthening of links between physics, chemistry, and engineering with the establishment in 1989 of a laser ablation facility at Birmingham that brought together researchers from physics, chemistry, electrical engineering, and metallurgy and materials to produce and

study thin films of the newly discovered high-temperature superconducting oxides.

He formally retired from the university in 1993 and became an emeritus professor.

In addition to his illustrious career at Birmingham, he held visiting appointments in the United States at the University of Pennsylvania, Stanford University, University of California–Berkeley, and Case Western Reserve University; and in Cape Town, South Africa; New South Wales, Australia; Hong Kong; and Novi Sad, former Yugoslavia.

He was active in the metallurgical societies, both local (Birmingham Metallurgical Association, BMetA) and nationally (Institute of Materials). He became president of the BMetA in 1972 and also served as vice president of the Institute of Metals, Metals Society, and Institute of Materials. For over 20 years he chaired the editorial committee of the *Metals Science Journal* (forerunner of *Materials Science and Technology*), and he took a prominent role in the development and growth of the Federation of European Materials Societies, including as president (1994–96).

In recognition of his extensive contributions he was awarded the Sir George Beilby Gold Medal of the Royal Institute of Chemistry and the Institute of Metals (1969), the Van Horn Distinguished Lecture Award (1978), the Rosenhain Medal and the Elegant Work Prize of the Metals Society (both in 1979), the Platinum Medal of the Institute of Materials (1989), and the Acta Materialia Gold Medal Prize (2004). In 1986 he was elected a fellow of the Royal Society and in 1991 a fellow of the Royal Academy of Engineering—membership in the premier UK societies of both science and engineering was a true reflection of Ray's interests and where he saw metallurgy as a discipline. He was named a Commander of the British Empire in 1992, and in 2005 elected as a foreign associate of the US National Academy of Engineering.

It is difficult to believe that this ever-bright light is now gone. He was no saint and he could be intimidating, but he was a loyal and very effective friend to metallurgy at Birmingham. He appreciated fully the nature of metallurgy

and the fact that it provides an essential bridge between science and engineering.

Ray had many tempting offers to move on to other pastures and could easily have reached the position of vice chancellor. But he did not succumb to these temptations; instead, he formulated a strategy and stuck with it, and through a combination of hard work, luck, and good judgment ensured the long-term health of metallurgy at Birmingham. We owe it to his legacy and to his memory to continue to resist the forces of short-termism and the view that "big is always beautiful."

Ray is survived by Doreen, Lesley-Ann, and Robert; and seven grandchildren.