Eur. Polym. J. Vol. 25, No. 7/8, pp. IX–XI, 1989
Printed in Great Britain

0014-3057/89 $3.00 + 0.00
Maxwell Pergamon Macmillan plc

TRIBUTE TO PROFESSOR JOHN BEVINGTON

Professor John Bevington has made an outstanding contribution to polymer chemistry for a period of over 40 years. His pioneering work with radiotracers during that time has resolved a multitude of uncertainties about the mechanisms involved in radical polymerizations. Consequently, a modern understanding of such mechanisms owes much to his efforts.

John graduated from Queens' College, Cambridge in 1943. He stayed in Cambridge to work with Fred Dainton, now Lord Dainton, as a research assistant. The research was government contracted, and because of this there were publication restrictions; nevertheless, it produced John's first research publication, on the oxidation and inflammation of yellow phosphorus [1]. John was subsequently appointed to a Research Fellowship and, during the tenure of this, worked with Professor Norrish on the cross-linking of vinyl polymers by Friedel–Crafts catalysts and also on the polymerization of aldehydes. These were to be his first serious excursions into polymer chemistry and formed the basis of the thesis for a Ph.D., which was awarded in 1949. He has subsequently always maintained an interest in aldehyde polymerization, publishing several reviews on the subject [2].

In 1948, John was appointed to a lectureship in Chemistry at the University of Birmingham. There, he was very shortly to be joined by the polymer group which moved with Professor (now Sir Harry) Melville from Aberdeen. Thus developed a flourishing group of polymer chemists of international repute led by Harry Melville and whose numbers, in addition to John himself, included Ivor Bengough, George Burnett, Frank Peaker, Norman Grassie and Leslie Valentine.

It was in Birmingham that John foresaw the tremendous potential of radiotracers for studying polymerization processes. If one was to study initiation processes in detail, it was necessary to develop a method of sufficient sensitivity to determine the level of incorporation of initiator fragments in polymers. Radiotracers provided such sensitivity, although their measurement in those days using Geiger counters was not often very efficient. John perfected the counting of ^{14}C products by combusting them to $^{14}CO_2$ and then counting them within a gas Geiger counter. He thus achieved almost 100% efficiency in counting and had a method which could be controlled to give both very great sensitivity and acceptable accuracy [3]. Such counting techniques, compared with the more recent scintillation counting methods, were laborious; but they were no less sensitive or accurate than the methods which have largely superseded them. Moreover, they had the considerable advantage in those days of being relatively inexpensive.

After John had developed the counting technique, there followed a very fruitful period in his career. There was scarcely an aspect of radical polymerization which did not benefit from his application of radiotracer techniques and his contributions to the subject played a major role in the success of polymer research at Birmingham in the 1950s and early 1960s. His outstanding achievements were recognized in the award of a D.Sc. by the University of Birmingham in 1957.

John's first application of radiotracers was to initiators. He established a direct means of monitoring rates and efficiencies of initiation, provided that initiator fragments are not incorporated in the polymer by subsequent steps [4]. Moreover, in combination with conventional molecular weight methods, he used labelled end-groups to determine the proportions of the two types of termination in radical homopolymerizations and copolymerizations [3].

The decomposition of initiators also came under John's scrutiny. By using labelled dibenzoyl peroxide, he demonstrated that yields of carbon dioxide could be used to study the reactivity of various compounds towards the primary benzoyloxy radical [5]. By suitable choice of the position of the label, he determined which of the two possible initiating species, the benzoyloxy or the phenyl radical, was responsible for initiation [6]. This led to an extensive study of this type of competition, using a range of monomers with different peroxide initiators. The concept of competition between reacting species for reference radicals, which was to be the basis for much of John's work over the next few years, was also extended to studies of copolymerizations [7].

The other aspects of radical polymerization benefitting from John's application of radiotracer techniques during his years in Birmingham are too many to enumerate, in full, in this appreciation. But his use of radiolabelling in studying transfer to polymer [8], transfer to initiator [9], transfer to solvent [10] and inhibition [11] were each important contributions. Where labelling with tritium was an advantage, he was not deterred by the immense difficulties, before the successful development of scintillation counting, of detecting this particular radionuclide; he extended the gas Geiger counting technique for this purpose by converting tritiated samples to acetylene [12].

During his years in Birmingham, John acquired a reputation for outstanding clarity in the presentation of lectures, whether to undergraduate audiences or to international gatherings of polymer chemists. This same gift for clarity was soon to manifest itself in the written word with the publication of his book *Radical Polymerization* [13]. That this work, although published almost 30 years ago, is still regarded as a standard text for many aspects of radical polymerization is a great tribute to John's mastery in perceiving the key areas of a subject.

It was no surprise to John's colleagues when he was appointed in 1963 to one of the first chairs created in the newly founded University of Lancaster, as Professor of Chemistry and Head of the Department of Chemistry. John rapidly set about building up research and teaching in the new Department, involving himself with typical energy and enthusiasm in every aspect of the new Department's activities, including acting as the director of studies for the first undergraduate intake.

It was at this time too that John became the Executive Editor of the newly founded *European Polymer Journal*. Under John's sure and careful guidance, this journal quickly became established as a leading journal covering the whole area of polymer chemistry.

At Lancaster John continued his research on applications of radiotracer techniques in polymer chemistry, including the determination of reactivities of monomers towards the phenyl radical using the reaction between the phenyl radical and DMF as the reference reaction [14], studies of the photodissociation of dibenzoyl peroxide [15], co- and ter-polymerizations [16, 17], hydrolyses of polyacrylates and methacrylates [18] and even in a study of the efficiency of a fractional precipitation [19].

In 1980, John realized that, whilst the use of radiolabelled initiators offered unrivalled sensitivity for the detection and estimation of initiator-derived end-groups in polymers, the use of initiators specifically labelled with certain NMR-active nuclei promised to provide a wider range of information. John was quick to show, in particular, that measurements of NMR signals of end-groups derived from ^{13}C-labelled initiators could provide information not only about reactivities of monomers towards primary radicals that were previously accessible only with great difficulty (e.g. towards the 2-cyano-2-propyl radical) but also about the structures of the terminal units of polymer chains [20, 21]. Thus began another very fruitful period of John's career, a period which has seen the publication of a large number of papers on NMR studies of end-group structures, most of which have been based on experiments carried out by John himself. This work gathered pace when John relinquished the Headship of the Department at the beginning of 1986, thus allowing him to spend more time 'at the bench'. These more recent studies have, for example, brought to light the unusually high reactivities of some monomers (e.g. stilbene) towards the benzoyloxy radical [22], have enabled the reactivities towards primary radicals of some unusual monomers (e.g. 2-vinylnaphthalene and 4-vinylbiphenyl) and some monomers with low ceiling temperatures to be assessed [23–25], have highlighted steric effects in the initiation of the polymerization of some 1,1-disubstituted ethylenes [26] and have revealed a higher than expected level of head-addition in the initiation step of the azobis(isobutyronitrile)-initiated polymerization of vinyl acetate [27].

Throughout his career John has displayed a strong interest and infectious enthusiasm in promoting chemistry and polymer science at all levels in the community. Many schoolchildren have been introduced to the delights of polymer science through John's schools' lecture *The Plastics Age*; countless students have enjoyed and been inspired by his lectures on topics as diverse as chemical kinetics, isotopes, polymerization, the oil industry, thermodynamics and industrial aspects of chemistry; and many young research workers have been encouraged by John's example to explore for themselves aspects of polymerization and polymer structure.

No appreciation of John's career to date would be complete without mentioning his recent enormous contribution to polymer science in overseeing, with Sir Geoffrey Allen, the production of *Comprehensive Polymer Science*, his continuing service as Chairman of the High Polymer Research Group and his many contributions to national and international conferences. The University of Lancaster also owes a particular debt of gratitude to John not only for his contributions as Head of the Department of Chemistry but also for past service as a Pro-Vice Chancellor and as the first Principal of Bowland College.

As will be realized, the publications cited in this appreciation represent only a fraction of John's published work but we hope that they serve to illustrate the many areas of polymer chemistry that have benefitted from John's careful scrutiny. The references will also serve as a guide to the many colleagues and friends, at Cambridge, Birmingham, Lancaster and elsewhere, who have collaborated with John over the years.

We are sure that all of John's friends and colleagues, past and present, with all those at the Symposium *Polymer Chemistry: Aspects of Radical Polymerization* being held in honour of John and at which this issue of *European Polymer Journal* is being published, will join with us in wishing him continuing success in his research and scholarship.

C. A. Barson
J. R. Ebdon

REFERENCES

1. F. S. Dainton and J. C. Bevington. *Trans. Faraday Soc.* **46,** 377 (1946).
2. e.g. J. C. Bevington. In *High Polymers* (Edited by N. G. Gaylord) Vol. 13(1), p. 9. Interscience, New York (1963).
3. J. C. Bevington, H. W. Melville and R. P. Taylor. *J. Polym. Sci.* **12,** 449, 463 (1954).
4. J. C. Bevington. *Trans. Faraday Soc.* **51,** 1392 (1955).
5. C. A. Barson and J. C. Bevington. *J. Polym. Sci.* **20,** 133 (1956).
6. J. C. Bevington. *Proc. R. Soc., A* **239,** 420 (1957).
7. e.g. J. C. Bevington, D. O. Harris and M. Johnson. *Eur. Polym. J.* **1,** 235 (1965).
8. J. C. Bevington, G. M. Guzman and H. W. Melville. *Proc. R. Soc. A* **221,** 437, 453 (1954).
9. e.g. J. C. Bevington, J. Toole and L. Trossarelli. *Makromolek. Chem.* **32,** 57 (1959).

10. e.g. J. C. Bevington and H. G. Troth. *Trans. Faraday Soc.* **59,** 127 (1963).
11. e.g. J. C. Bevington. *J. chem. Soc.* 1127 (1956).
12. J. C. Bevington and D. E. Eaves. *Makromolek. Chem.* **36,** 145 (1960).
13. J. C. Bevington. *Radical Polymerization.* Academic Press, London (1961).
14. J. C. Bevington and T. Ito. *Trans. Faraday Soc.* **64,** 1329 (1968).
15. P. K. SenGupta and J. C. Bevington. *Polymer* **14,** 527 (1973).
16. J. C. Bevington and M. Johnson. *Eur. Polym. J.* **4,** 687 (1968).
17. J. C. Bevington and C. Nicora. *Polymer* **13,** 249 (1972).
18. F. C. Baines and J. C. Bevington. *J. Polym. Sci., A-1* **6,** 2433 (1968).
19. F. C. Baines and J. C. Bevington. *Eur. Polym. J.* **3,** 593 (1967).
20. J. C. Bevington, J. R. Ebdon, T. N. Huckerby and N. W. E. Hutton. *Polymer* **23,** 163 (1982).
21. J. C. Bevington, J. R. Ebdon and T. N. Huckerby. *Eur. Polym. J.* **21,** 685 (1985).
22. J. C. Bevington and T. N. Huckerby. *Macromolecules* **18,** 176 (1985).
23. J. C. Bevington, T. N. Huckerby and B. J. Hunt. *Br. Polym. J.* **17,** 43 (1985).
24. K. Behari, J. C. Bevington, S. W. Breuer and T. N. Huckerby. *Eur. Polym. J.* **24,** 187 (1988).
25. C. A. Barson, J. C. Bevington, S. W. Breuer and T. N. Huckerby. *Polym. Bull. (Berlin)* **20,** 31 (1988).
26. K. Behari, J. C. Bevington and T. N. Huckerby. *Polymer* **29,** 1867 (1988).
27. J. C. Bevington, S. W. Breuer, E. N. J. Heseltine, T. N. Huckerby and S. C. Varma. *J. Polym. Sci.; Part A, Polym. Chem.* **25,** 1085 (1987).