Book Reviews[1]

Handbook of Nuclear Chemistry, **Volumes 1, 2, 3, 4, and 5**. Edited by Attila Vértes (Department of Nuclear Chemistry, Eötvös Loránd University, Budapest, Hungary), Sándor Nagy (Department of Nuclear Chemistry, Eötvös Loránd University) and Zoltán Klencsár (Research Group for Nuclear Techniques in Structural Chemistry, Hungarian Academy of Sciences at Eötvös University Budapest). Kluwer Academic Publishers, Dordrecht, Boston, London. 2003. xiv + 560 pp, x + 527 pp, x + 553 pp, xvi + 398 pp and viii + 406 pp. USD 1575, EUR 1600, GBP 1000; ISBN 1-4020-1305-1 for the set of five volumes (ISBN for separate volumes are given in the review).

The first editor, Vértes, is a renowned and distinguished nuclear scientist, who recently has been awarded the prestigious Hevesy Medal Award for his achievements in the field of radioanalytical and nuclear chemistry, including his activities in writing and editing textbooks and monographs. The present handbook may be seen as his *magnum opus*, being implicitly an update and also a considerable extension of his earlier book "Nuclear Chemistry" written jointly with Kiss (Elsevier, Amsterdam, Akadémiai Kiadó, Budapest, 1987).

For the present handbook Vértes and his two co-editors Nagy and Klencsár used another approach. They acted not so much as writers themselves, but rather as conductors, orchestrating topics of the wide spectrum of nuclear science and methodology into a symphony, thereby conducting an international ensemble of well-known players to achieve harmony. In total 77 authors contributed as experts in the

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[1] Unsigned reviews are by the book review editor. Please forward books for review to the book review editor: Magdolna Hargittai, Structural Chemistry Research Group of the Hungarian Academy of Sciences, Eötvös University, H-1518 Budapest, Pf. 32, Hungary

relevant fields. A large share originates from Hungary (24), and the rest from Austria (1), Belgium (2), Denmark (1), Germany (10), Japan (11), Russia (2), Sweden (4), Switzerland (4), UK (1), and USA (17).

The editors have chosen the title "(Handbook of) Nuclear Chemistry" for their handbook. This entails the risk that the content of the book, and consequently its merits, cannot be derived from its title alone. The editors have motivated their choice by the consideration that "nuclear chemistry" and "radiochemistry" have become practically synonymous (Volume 1, page x). However, for many scientists in the field, nuclear chemistry and radiochemistry – although having overlaps – are still different disciplines, as also is evident from current textbooks on either nuclear chemistry or radiochemistry.

For the composition of the handbook the editors had to deal with the demarcation line between what should be considered as characteristic of and/or directly related to nuclear and radiochemistry for inclusion and what not. In the selection of topics they have displayed a comprehensive vision considering a large spectrum of topics, so that the handbook has become far more exhaustive than any of the existing books on nuclear chemistry and/or radiochemistry. The handbook includes various other topics – related to nuclear aspects, isotopes or ionising radiation. For instance, it deals with nuclear and atomic physics (*e.g.* the standard model of elementary particles, neutron scattering, Mössbauer spectroscopy, positron annihilation spectroscopy, exotic atoms and muonium), health physics (*e.g.* dosimetry), mathematics (*e.g.* statistical aspects), biology (*e.g.* biological effects of ionising radiation), chemistry (*e.g.* radiation chemistry, superheavy elements, thermography, radioactive waste management), geology and cosmology (*e.g.* origin of the universe and constituting chemical elements, paleoclimatology and radioactive

dating). On the other hand, nuclear topics, not involving nuclear transformations and/or ionising radiation, have not been included, *e.g*. nuclear magnetic resonance. Also the “atomic” techniques of mass spectrometry and of particle-induced X-ray emission, sometimes considered as associated with or incorporated in the domain of nuclear techniques, are absent.

Due to the wide scope, the handbook has become an impressive and fascinating work, positioning nuclear fundamentals and methods firmly and clearly within the spectrum of pure and applied natural sciences. The comprehensive and unique nature of the handbook can be best demonstrated with a summary of the contents of the chapters and appendices in the separate five volumes:

- **Volume 1, Basics of nuclear science** (xiv + 560 pages; ISBN 1-4020-1313-2): History of nuclear and radiochemistry, basic properties of the atomic nucleus, nuclear reactions, nuclear fission, kinetics of radioactive decay, interaction of radiation with matter, statistical aspects of nuclear measurements, standard model of elementary particles. Appendices: (1) The international system of units SI and units outside the SI, (2) fundamental constants and conversion factors, (3) elements and isotopes: chemical elements and their properties, atomic weights and isotopic compositions, (4) atomic data: atomic-electron binding energies, X-ray energies and intensities, and internal conversion coefficients, (5) absorption of radiation in matter: X-ray and gamma-ray attenuation coefficients, stopping power and range of charged particles, (6) nuclear masses and separation energies.

- **Volume 2, Elements and isotopes** (x + 527 pages; ISBN 1-4020-1314-0): The origin of chemical elements, natural decay chains, radio-elements, isotope effects, isotopic paleoclimatology, radioactive dating methods, production and chemistry of

transuranium elements, production and identification of transactinide elements, chemistry of transactinides, superheavy elements. Appendix: table of nuclides.

- **Volume 3, Chemical applications of nuclear reactions and radiations** (x + 553 pages; ISBN 1-4020-1315-9): Radiation chemistry, hot atom chemistry, Mössbauer spectroscopy, Mössbauer excitation by synchrotron radiation, positron annihilation spectroscopy, exotic atoms and muonium, neutron scattering methods in chemistry, activation analysis, application of neutron generators, chemical application of accelerators, tracer technique. Appendices: (1) Mössbauer nuclides, (2) thermal neutron reaction data, (3) fast neutron reaction data, (4) reference materials.

- **Volume 4, Radiochemistry and radiopharmaceutical chemistry in the life sciences** (xvi + 398 pages; ISBN 1-4020-1316-7): Reactor-produced radionuclides, cyclotron production of radionuclides, radionuclide generators, ^{11}C labelling chemistry and labelled compounds, ^{18}F labelling chemistry and labelled compounds, ^{99m}Tc labelling chemistry and labelled compounds, radioiodination chemistry and radioiodinated compounds, radiometals and bifunctional labelling chemistry, radionuclide therapy, dosimetry and biological effects of ionising radiation.

- **Volume 5, Instrumentation, separation techniques and environmental issues** (viii + 406 pages; ISBN 1-4020-1317-5): Radiation detection, dosimetry methods, particle accelerators, technical application of nuclear fission, isotope separation, solvent extraction and ion exchange in radiochemistry, radiochemical separations by thermography, environmental radioprotection, radioactive waste management. Appendices: (1) Standards for detector calibration: X-ray and gamma-ray sources, electron and alpha sources, (2) fission product yields.

Each chapter forms generally a complete whole, keeping the balance steady between conciseness and completeness, and showing liveliness due to the varying

writing style of the authors. On the other hand, so many authors entail the risk that differences in view or expression may occur. For instance, in the definition of *specific activity* (Bq/kg) the normalising factor mass is stated as that of the sample, and it is said that *activity concentration* (Bq/dm^3) is a similar quantity (Volume 1, page 258); this may lead to misunderstanding of the concept specific activity in radiochemistry. Elsewhere, the specific activity is correctly interpreted and/or used as related to the total mass of nuclides, isotopic with the radionuclide involved (e.g. Volume 1, page 13; Volume 4, pages 123 and 258). Also insufficient discrimination is made between *carrier-free* and *no-carrier-added* (*e.g.* Volume 1, page 258; Volume 3, page 446), which are considered as almost synonymous or identical, but certainly are not. It is a pity that these crucial concepts in radiochemistry, sometimes used inadequately or even wrongly by scientists in the field, are not dealt with here more unambiguously and coherently.

The chapters quite often contain a short (historical) introduction, sometimes remarks about future developments or perspectives and at the end suggested further readings, in addition to a standard list of references. The clear arrangement of the various topics, extensive indexes in each volume, a short summary at the start of each chapter, in most chapters the use of bold characters in the text when introducing a new concept, facilitate its use as a reference work. The various appendices on units, physical constants, nuclear and atomic data, and reference materials enhance the usefulness of this handbook, and justify having this handbook close at hand.

Altogether, due to the comprehensive character this handbook is indispensable for students and researchers in the nuclear field at large. In addition, it is also useful for scientists from the disciplines of biology, medicine, physics, and chemistry, showing the wealth of nuclear and radiochemical methods to solve their problems and to

achieve progress in their fields. The five separate volumes may be of special interest to particular groups, *e.g.* Volume 1 for graduate students studying basic principles in natural sciences in general and in nuclear science in particular, Volume 2 for geologists and cosmologists, Volume 3 for chemists interested in nuclear techniques for elemental and structural analysis as well as in radiotracer applications for study of mechanistic, temporal and/or spatial behaviour, Volume 4 for workers in the field of radiopharmacy and nuclear medicine, and Volume 5 for scientists and technicians performing or supervising work with radionuclides and radiation.

It is now more than half a century ago that President Eisenhower of the USA announced the program “Atoms for peace”. This has given the onset to a widespread use of nuclear techniques in science, technology and medicine. In addition to generation of electric power (including ship propulsion), nuclear techniques have provided information and solutions, which could not or not so easily be obtained otherwise. This has undoubtedly contributed to prosperity and well-being of many. Unfortunately, nowadays there is much groundless public opposition against so much what is or may be labelled as “nuclear”, and in the view of opponents should be avoided, abandoned or even abolished. The handbook is a helpful basis for scientists to disseminate relevant and interesting information on nuclear topics to a large public. In particular showing that nuclear and associated radiation aspects are quite natural phenomena (human life on earth today would not exist without), and especially that mankind has benefited much and still may benefit in many respects from a variety of nuclear techniques and methods when properly used.

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