# BOOK REVIEWS

## Cardiovascular Biomaterials and Biocompatibility

L. Harker, B. Ratner and P. Didisheim
Published as a supplement to *Cardiovascular Pathology* volume 2, 1993, 219 pp.

Investigators concerned with blood–material interactions have just been presented with an important new reference with the publication of 'Cardiovascular Biomaterials and Biocompatibility: A Guide to the Study of Blood–Tissue–Material Interactions'[1]. This work represents the fourth edition of what have been previously entitled, Guidelines for Blood–Material Interactions–Reports of the National Heart, Lung, and Blood Institute Working Group[1–3]. However, this latest edition is published for the first time in a journal format as a special supplementary issue of *Cardiovascular Pathology*; the official Journal of the Society for Cardiovascular Pathology. The editors of the supplement are Drs Lawrence Harker, Buddy Ratner, and Paul Didisheim. The editors and contributors are to be commended for an outstanding contribution to the cardiovascular biomaterial literature. This work will be very useful as a guide for both experienced researchers as well as students.

In general, all of the chapters are well written and the contributing authors represent the leaders in this field. Although there is some overlap between the chapters, the overlap in general is complementary. In addition, some of the chapters have a handbook format. For example, the extensive tabular information references in Chapter 6 (Materials Selection) could be particularly useful for workers seeking specific material characteristics. However, this type of extensive tabular information might be best included in an appendix.

Despite the many praiseworthy contributions to 'Cardiovascular Biomaterials and Biocompatibility', there are a number of important subjects which were not included, and hopefully these will be covered in future editions. For example, the use of animal models is not specifically covered. There is no attempt made in any of the chapters to differentiate between results or data obtained from animal models versus human material. There are important differences between human and animal blood–material interactions, and it would be helpful if these were delineated in future editions, perhaps in a chapter on this subject.

Another important missing subject area concerns the use of mathematical modelling techniques to understand the performance of cardiovascular biomaterials, and help predict their biocompatibility[4–6]. In addition, in a number of industrial settings, certain computerized mathematical modelling techniques are already in standard use. For example, heart valve design is frequently aided by finite element analysis[7,8]. In addition, mathematical modelling and computer simulation of thrombogenesis have also been attempted by a number of investigative groups[9,10].

Furthermore, while the descriptions of a number of techniques available for assessing cardiovascular biomaterials are very helpful, a number of currently available techniques which could augment experiments and testing are not mentioned at all. An important example in this regard is solid state nuclear magnetic resonance, which has been recently reviewed[11,12], and represents a powerful tool for understanding the chemical nature and chemical interactions of polymeric surfaces. Another technique omitted in this work is accelerated fatigue testing of cardiac valve prostheses. This methodology is used extensively in the cardiac valve industry for estimating durability[13,14]. The results of accelerated fatigue testing are virtually always part of the data submitted to the Food and Drug Administration for cardiac valve prosthesis approval. Furthermore, techniques involving NMR imaging provide important information about biomaterials at the bulk and molecular level and thus should also be considered for inclusion in future editions of this publication. NMR imaging techniques have been used to study cardiovascular biomaterials to a limited extent[15], and it is expected that this use will increase with the increasing availability of this type of instrumentation.

The reviewer would hope to see an expanded appendix in future editions of 'Cardiovascular Biomaterials and Biocompatibility'. This appendix might contain some of the handbook features mentioned above, as well as references to various literature and computer databases concerning materials. Furthermore, the appendix might also include a summary of various methods which could be useful for researchers in this field. The appendix might even be more useful if it contained a listing of the names and other contact information for manufacturers and suppliers of various materials relevant to research in this field.

Despite these constructive concerns and recommendations about future issues, congratulations are in order to all who participated in the creation of this fourth outstanding edition of 'Cardiovascular Biomaterials and Biocompatibility'.

## REFERENCES


1 Guidelines for Blood–Material Interactions, (N.I.H. Devices and Technology Branch, Heart, Lung, and Blood Institute), NIH Publication No. 80-2185, Bethesda, Maryland, 1980.
2 Guidelines for Physicochemical Characterization of Biomaterials, (N.I.H. Devices and Technology Branch,



0142-9612/94/040317-02

Heart, Lung, and Blood Institute), NIH Publication No. 80-2186, Bethesda, Maryland, 1980.
3 Guidelines for Blood–Material Interactions, in Report of the National Heart, Lung, and Blood Institute Working Group, (N.I.H. Devices and Technology Branch, Heart, Lung, and Blood Institute), NIH Publication No. 85-2185, Bethesda, Maryland, 1985.
4 Colton CK. Analysis of membrane processes for blood purification. *Blood Purif* 1987; **5:** 202–251.
5 Mendel CM. Binding of lipoproteins in inert materials revisited with computer-assisted analysis. *Biochim Biophys Acta* 1987; **918:** 205–207.
6 Stevenson DM, Yoganathan AP and Williams FP. Numerical simulation of steady turbulent flow through trileaflet aortic heart valves—II. Results on five models. *J Biomech* 1985; **18:** 909–926.
7 Knierbein B, Mohr MU, Rechlin M, Raul H, Rau G and Michaeli W. Evaluation of mechanical loading of a trileaflet polyurethane blood pump valve by finite element analysis. *Int J Artif Organs* 1990; **13:** 307–315.
8 Huang X, Black MM, Howard IC and Patterson EA. A two-dimensional finite element analysis of a bioprosthetic heart valve. *J Biomech* 1990; **23:** 753–762.
9 Hubbell JA and McIntire LV. Platelet active concentration profiles near growing thrombi. A mathematical consideration. *Biophys J* 1986; **50:** 937–945.
10 Khanin MA and Semenov VV. A mathematical model of the kinetics of blood coagulation. *J Theor Biol* 1989; **136:** 127–134.
11 Veeman WS and Bijl G. NMR imaging of solids with magic angle spinning. *Magn Reson Imaging* 1992; **10:** 755–763.
12 Segre A and Capitani D. NMR in solid polymers. *Trends Polym Sci* 1993; **1:** 280–284.
13 Schuster PR and Wagner JW. A preliminary durability study of two types of low-profile pericardial bioprosthetic valves through the use of accelerated fatigue testing and flow characterization. *J Biomed Mater Res* 1989; **23:** 207–222.
14 Iosif MC and Gabbay S. A system for in-vitro characterization of heart valve bioprostheses under accelerated fatigue conditions and under physiologic conditions. *Biomed Instrum Technol* 1992; **26:** 408–413.

**Robert J. Levy**
*University of Michigan Medical School*
*Ann Arbor, MI, USA*

# High Resolution XPS of Organic Polymers: The Scienta ESCA300 Database

G. Beamson and D. Briggs
John Wiley, Chichester, UK 1992

Interfacial chemistry has a profound influence on processes such as adhesion, wetting and protein adsorption. Precise knowledge of such chemistry is therefore vital to any systematic study of processes where surface interactions occur. The application of X-ray photoelectron spectroscopy (XPS) in the study of surfaces including biomedical interfaces is well established. This book describes the ESCA (electron spectroscopy for chemical analysis) database of a range of standard and biomedical polymers using the high resolution Scienta ESCA300 instrument.

The book is divided into four main parts, the first being a brief description of the spectrometer and its performance. The second part covers the experimental and analytical techniques employed to acquire the spectra, which are then given in the third section. Of particular note is the inclusion of valence band spectra, which may be used to distinguish, for example, linear and branched polyolefins. Finally, the appendices supply a summary of group chemical shifts and binding energies. The layout enables easy referencing for both the identification of unknown samples and the characterization of novel surfaces.

The authors have collected spectra from over a hundred commonly used polymers. Although XPS spectra of many of these materials are to be found in the literature, what makes this database indispensable is the exceptional energy resolution available from the Scienta ESCA300. Most XPS users do not have access to such expensive equipment, but even so, the precision with which binding energies and chemical shifts have been determined (due in large part to careful energy-referencing by the authors) makes the book an invaluable tool for academics and industrial scientists who are employing XPS to characterize polymeric biomaterial interfaces.

**M. Davies**