book reviews

Materials for Microlithography: Radiation Sensitive Polymers

L. F. Thompson, C. G. Willson and J. M. J. Frechet (Eds.)
American Chemical Society, 1984, 496 pp., US $65.95.
ISBN 0-841-20871-9

Remarkable progress in the miniaturization of electronic devices over the past three decades promises to continue for many years. The size (area) of the chips has not changed significantly over the years, whereas the size of each element has decreased from above 20 microns in 1963 to less than 2 microns in 1983. Microlithography is the heart of semiconductor manufacture. This publication is the report of a symposium cosponsored by the Division of Polymeric Materials Science and Engineering and the Division of Polymer Chemistry at the 187th meeting of the American Chemical Society at St. Louis in 1984.

Unlike many of the publications in this series it is not just a report of a conference proceedings but is written and presented to provide the reader with a balanced view of materials used in microlithography. The present volume extends the topics presented in 'Introduction to Microlithography' (Ed. L. F. Thompson, C. G. Willson and M. J. Bowden). This latter volume is an excellent tutorial text on microlithography and in particular photo, electron beam and X-ray techniques. The present volume is rather narrower than the previous one in its coverage and focusses on radiation sensitivity of polymers, however the broader aspects of lithography are covered in three excellent introductory chapters.

The opening chapter by Everhart considers the factors which fundamentally limit the sensitivity of lithographic processes. Broers considers practical and fundamental aspects of lithography. It is of interest to note that serious attention is given to electron storage rings and justifies the bias of this volume towards photochemical processes. A broad review of resist materials for fine line lithography which is an in-depth discussion electron beam and X-ray lithography. The remaining papers are divided into two sections, fundamental radiation chemistry and resist materials and applications.

The section on radiation chemistry opens with a chapter which discusses polymer degradation by high energy radiation. Microlithography was initially very much a trial and error subject which is now seeking a more fundamental base. This excellent introduction to radiation chemistry and provides a basis for understanding the processes occurring when resist materials are subjected to high energy particle beams. The other chapters in this section deal with pulse radiolysis of chloromethylated polystyrene, a material which is being widely considered as a negative electron beam resist. The subject of photochemistry in the area of microlithography is discussed by Guillet in a review centred on ketone polymers. The subject of radiation interaction with polymers is extended in chapters dealing with radiolysis of poly(isoprpenyl t butyl ketone), laser induced polymerization, polymer bonded electron transfer sensitizers, novel synthesis and photochemical reaction of the polymers with pendant photosensitive and photosensitizer groups and novel techniques for determining radiation chemical yields of negative electron beam resists. These chapters indicate the increasing awareness of workers in the microlithography area of a need to understand the fundamental processes occurring in resist materials.

The second section of the book is concerned with resist materials and their applications and opens with a chapter on the photo-Fries rearrangement and its use in polymeric imaging systems. The emphasis in this section is upon photochemistry and topics covered include organic direct optical recording media, primary and secondary reactions in photoinitiated free radical polymerization of organic coatings, photochemistry of ketone polymers, new radiation-sensitive polymers based on polysilane derivatives, novolac resins for use in photolithography. Electron beam resist materials are not completely neglected and chapters dealing with positive weakening electron beam resists based on maleic anhydride copolymers, chlorinated polymethylstyrene, phenolic resins containing epoxy and aside compounds, alpha substituted benzyl methacrylates and ketone polymers.

This text is not only a well-edited conference report; it is also a very useful complement to the earlier publication. Polymeric materials, especially the radiation-sensitive polymers, lie at the heart of microlithography. For the first time, it will be necessary for the development engineer as well as the scientist to possess a thorough understanding of the chemistry of radiation-sensitive polymers. This book provides the foundation for such an understanding. Although the book is based on research papers presented at a symposium, it has been constructed so as to provide a tutorial text complementing the previous introductory text on this topic.

This text is strongly recommended to those interested in obtaining an understanding of microlithography as currently applied, as well as in developing the materials science which underlies this subject. Unfortunately these texts are rather expensive in the UK; although more modestly priced in the USA. Despite the price barrier I am sure that the serious worker in this research area will find this addition to the literature a necessary purchase for their library.

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Surface coatings

Swaraj Paul
J. Wiley and Sons, 1985, 741 pp, £48 ISBN 0-471-90397-3

Devoted to the science and technology of paints, the book first deals with the chemistry and industrial production of polymeric binders (310 pp), and then with pigments (64 pp), before proceeding to paints and paint properties (180 pp). Finally there is a section (175 pp) on the newer technologies, such as the modifications made during the last two decades in response to legislation in certain countries, to reduce dependency upon volatile and possibly harmful organic solvents in surface coatings.

The first chapter on the synthesis of polymeric binders briefly covers the essentials of polymerization theory in preparation for a full discussion of the chemistry of those industrial resins that are important in paint systems: alkyds and polyesters, formaldehyde systems, epoxy resins and so on. It is typical that the section on silicone resins commences with an exposition of their differences from, and advantages over, alkyl resins, and a citation of the recent relevant reviews. The type of alkyl or aryl substituent determines such paint characteristics as