Introduction to Synthetic Electrical Conductors

John R. Ferraro and Jack M. Williams
(Academic Press, 1987)

The study of synthetic metals is now well established as a major subfield of materials science research. It is simultaneously resilient and highly dispersed: periods of relative calm in family A are offset by breakthroughs in B, but after 25 years there is still very little interfamily cross-fertilization. Apart from NATO schools in 1979 and 1987, conference organizers and book editors have made no effort to provide unifying treatments of conducting polymers, organic charge transfer compounds, layer intercalates, Krogmann salts, etc. An ideal introduction would serve both as graduate-level text and a guide to new research, and would convey some of the interdisciplinary excitement that created the field. The present volume represents the first attempt to meet this formidable challenge in a single monograph.

An introductory chapter motivates the subject largely in terms of the search for new superconductors. Four chapters of roughly equal length follow covering organic charge transfer compounds, polymers, Krogmann salts, and transition metal-macrocyclic ligand complexes. A brief fifth chapter covers graphite intercalation compounds and polymer electrolytes. The treatment is historical and descriptive, emphasizing synthetic and physical chemistry; and much of the material comes from reviews published in the late 1970s and early 1980s. Two final chapters provide some balance by presenting a classification of one-dimensional instabilities, a brief discussion of electron localization, and a survey of pressure effects in selected materials. The book closes with a useful post-deadline bibliography (up to 1986) and a three-page echo of the introduction summarizing high T_c state-of-the-art as of mid-1987.

It troubles me to report that this admirable attempt has produced a less-than-satisfactory result which will have limited appeal. The main problem is that the authors apparently had no clear idea of their intended audience. Total newcomers would have benefited more from an exposition of the overarching themes and could have done with less detail and tabular information, while those already in the field will gravitate toward the numerous review articles. The physics-oriented reader would appreciate a sense of the synthetic intuition which often leads to exciting new compounds.

The few examples where cross-fertilization has been useful deserve to be underscored, e.g., electrochemical doping in polymers and graphite, Lewis acids as a common approach to the best conductivities in these two synthetic conductor families, etc. Competing interactions in graphite intercalates lead to the staging phenomenon, unusual phase transitions, and novel kinetic phenomena; these ideas are being extended to doped polymers, and one finds examples of (at least) the same language in recent high T_c papers.

No mention is made of intercalated graphite fibers, which offer perhaps the best promise for practical realization. The novice will also wonder what theoretical conductivity limits may exist within the various families. Inclusion of the adjective "1-D" in the title would have helped the potential buyer identify the contents.

The book will serve as a useful first look at the four main families, but strong competition exists in the general or specialized volumes of the NATO series, conference proceedings in synthetic metals and elsewhere, the Springer solid state science series, and the standard review article literature. A good interdisciplinary introduction to the full scope of this exciting field is still sorely needed.

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Ionized Cluster Beam Deposition and Epitaxy

By Toshinori Takagi
(Noyes Publications, 1988)

This book, which Toshinori Takagi signs as author, is a review of 17 years worth of work which the Kyoto group and others have contributed to this field.

Ionized cluster beam (ICB) deposition, a relatively new technique, provides films with properties different from those obtained by conventional vapor deposition. The technique involves ejecting atoms through a small nozzle (typically 2 mm wide and 2 mm long) from a high pressure region into a low pressure one. This facilitates an adiabatic expansion. For the ejection of gases these processes have indeed led to sizeable clusters of atoms and played an important role during early attempts for nuclear fusion (e.g., at the nuclear research center in Karlsruhe, Germany). It is said that a visit to this laboratory inspired Prof. Takagi to try a similar method for deposition of solids.

In ICB the metal is heated in a carbon crucible to a very high temperature and then ejected into a high vacuum (10^7 to 10^5 torr range or better). The nozzle diameter of the crucible must be larger than the mean free path of the atoms in the vapor in order to expect atom clusters to form in this area. (By following the literature one observes that it is still debated whether an appreciable number of clusters are indeed formed and what size these possible clusters might have). In any event, the resulting particle stream is partially ionized by impact of electrons and then accelerated in an electric field of several kilovolts toward the substrate.

Putting aside the methodical details of ICB, the results as presented in the monograph are impressive. The topics covered include properties of metals (thin conductive films, ohmic contacts, aluminum metallizations) intermetallic compounds (films of MnBi, $FeSi_2$, CdTe, etc.), semiconductors (Si, III-V compounds), compound films (ZnO, BeO, SiC, MgF_2, etc.) and organic materials (such as anthracene or polyethylene).

The book was written by combining the efforts of Drs. Jerome J. Cuomo and Stephen M. Rossnagel (IBM), who helped with the original manuscript, and contributions from Prof. I. Yamada, much of whose work is included in the text.

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Block Copolymers, Low Pressure Diamond Growth, MOD, Magnetism in Europe, Zeolites

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