

PREFACE

When I started working on the chemistry of solid materials nearly 50 years ago, there were very few practitioners in the subject. Much of the preoccupation of those who worked in this area was on point defects in solids and nonstoichiometry. J.S. Anderson (Oxford), who was a source of inspiration to many of us, was seriously interested in the relation between nonstoichiometry and defects. Nonstoichiometry was a problem that plagued chemists for a long time since people were dismayed by compounds such as Ti_4O_7 and Pr_6O_{11} with unusual cation:anion ratios. In the late 1960's, it was established that these arose because of certain novel structural manifestations, typical of them being crystallographic shear planes and defect complexes. The subject of solid state chemistry grew slowly over the years, with people working on the structure and properties of materials. In particular, research on transition metal oxides was pursued by a number of solid state chemists, and the effort in organic solid state was marginal.

Transition metal oxides are fascinating because of the very wide range of properties and structures exhibited by them. I myself got into this area in the early 1960s. Two major researchers around that time were, my dear friends John Goodenough and Paul Hagenmuller. Several important discoveries were made in this area during that period. For example, metallic oxides such as ReO_3 were reported. ReO_3 looks like copper and conducts like copper. Oxides undergoing transitions from the insulating state to the metallic state were discovered, the most prominent amongst them being V_2O_3 , showing a 10-million fold jump in resistivity around 150 K. My interest in such transitions was aroused by my association with J.M. Honig. V_2O_3 continues to be a problem of interest even today. Research on other types of materials such as chalcogenides and pnictides was also pursued by some workers, but oxides of different structures, specially those belonging to the perovskite family, received greater attention. It was really enjoyable to work in this area and I specially recall my association with Nevil Mott whom I consider to be the father of modern of solid state and materials science.

The biggest explosion in materials chemistry and physics occurred in late 1986 when high-temperature superconductivity was discovered in a lanthanum cuprate, a material which was a ceramic and on which a few chemists had worked earlier. As stated in a report of the US National Academy of Sciences, this discovery changed the role of chemistry in the study of materials, and materials chemistry became a more significant part of materials science. It is around this time that even chemists started to consider solid state chemistry as an integral and important part of main-stream chemistry.

In the last thirty years or so, the subject of solid state chemistry has got transformed into materials chemistry by absorbing various features of modern chemical science. The materials investigated by chemists are no longer limited to inorganic materials but include a variety of organic materials. Synthesis has become a major aspect of materials chemistry. Materials chemists employ a variety of chemical strategies, soft chemical approaches, in particular, for synthesis. Studies of structure, properties and phenomena and relating structure to properties are important aspects of materials chemistry.

Computation and theory are used extensively. Supramolecular strategies are employed to design materials. Materials chemistry is now truly interdisciplinary, not only within chemical science itself but also by having interfaces with biology and other subjects. It has immediate connections with physics, engineering and technology.

In this collection, I have included a set of my papers which represent some of the highlights of materials chemistry. There is a section on oxidic materials, which includes high-temperature superconductivity, colossal magnetoresistance, electronic phase separation and multiferroics. I could have included other areas as well as materials such as nitrides but could not do so because of limitation of space. We have, in fact, employed novel methods for making gallium nitride, boron nitride and such materials, by using precursors and the urea decomposition route. There is a section dealing with open-frame work and hybrid materials of which the latter has a great future since one can make use of the rigidity of inorganic structures and the functionality and flexibility of the organic residues to design materials with novel properties. I have had the pleasure of carrying out some collaborative work on hybrid frameworks with A.K. Cheetham. Nanomaterials, the new fascination, constitute a large section of the book. I have not been able to include many papers on organic materials since I have not worked in this area extensively.

The book was intended to be a selection of my research papers which in turn also presents the flavor of modern materials chemistry. I trust that I have succeeded, at least partly, in doing so. I realize that it is difficult to be up-to-date in a field like this since new materials, methods and phenomena are discovered constantly. Even as I write this preface, new results of vital importance have been obtained in my laboratory which cannot be included in this volume. I earnestly hope that the reader will find the papers in this volume interesting and informative, and representative of the subject. It has been a pleasure to see the subject grow in the last half a century, and to grow with it. I have no doubt that materials chemistry will continue to develop and unravel new horizons in the years to come.

I am most thankful to the Indian Institute of Science, specially its Director, Professor P. Balaram, for asking me to deliver the inaugural centenary lecture of the Institute. I owe much to the Institute where I have done most of my research work, and to the fine students and coworkers I have had over the years. It is to be noted that the centenary of the Indian Institute of Science coincides with my 75th birth anniversary and 50 years of research as an independent faculty member.

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