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Molecular Crystals and Liquid Crystals

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Introduction

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INTRODUCTION

During the past decade there has been extensive study and a tremendous increase in understanding of low-dimensional solids. These systems are found among molecular, metal complex and polymeric materials. As a result of parallel chains or stacks of molecules, members of these groups of materials frequently have very anisotropic properties and indeed are often "one-dimensional". The availability of such one-dimensional systems has opened opportunities to test the physical concepts developed for one-dimensional systems. The synergism of theoretical and experimental physics with synthetic chemistry has resulted in a dynamic field.

Two recent developments have led to an increase in research activity. In 1977 it was reported (Heeger-MacDiarmid-Shirakawa) that the electrical properties of some insulating organic polymers can be tuned from insulator to metal by doping. In early 1980 a joint French-Danish group (Jerome-Bechgaard) announced the discovery of BCS superconductivity in a molecular stacked conductor. It is clear that the full potential of low-dimensional solids has not yet been explored.

The International Conference on Low-Dimensional Conductors was held at Boulder, Colorado, U.S.A. during 9-14 August, 1981. It was the successor to conferences held earlier in Siofok (1976), New York (1977), Dubrovnik (1978) and Helsingor (1980). The purpose of this conference was to provide an interdisciplinary forum for the discussion of recent experimental and theoretical results in the physics, chemistry and applications of low-dimensional conductors. The vigor of this field is evidenced by the fact that over 235 papers were presented at the meeting, making it by far the largest meeting held in the field to date. The abstracts (by first author) came from 20 countries, with more than one-half contributed by scientists outside the U.S. A list of participants is included in the first volume.

Polyacetylene turned out to be the single most popular material at the conference, occupying two full oral sessions, parts of several others and a full poster session. Soliton theory has grown sufficiently to have warranted a session of its own. With two oral sessions and one poster session, the second most popular material, or more properly set of materials, was $(\text{TMTSF})_2\text{X}$, where X stands for one of perhaps a dozen

different counter-ions. NbSe_3 and its close relatives have expanded to the extent that they occupied the equivalent of a complete oral session and a sizeable portion of a poster session. About half the conference was devoted to other materials, with at most a few papers on any single one, including the favorites of yesteryear, and very many papers on new and exotic materials. It will be interesting to see which of these is starred at the next conference!

The proceedings are being published as a series of volumes (probably five) in "Molecular Crystals and Liquid Crystals". In order to provide the most accurate picture of the present state of the field, with unanswered questions and controversies clearly visible, we have made an effort to minimize interference with the views expressed by the authors in these volumes. The contributions are organized by topic, but of course there is much overlap among both concepts and materials.

The first volume begins with experimental studies of polyacetylene, including interpretations based on the role of solitons in doping, optical properties and, as recently proposed, in electron hopping transport in lightly doped trans-polyacetylene. It continues with papers on the structure and morphology of polyacetylene. In this area the issue of the mechanism of cis- to trans-isomerisation has forced a reexamination of some of the widely used pictures. Finally there is a group of papers on soliton theory, including the recently developed theory of fractional soliton charges in systems of commensurability higher than two and the development of polaron concepts for one-dimensional systems. A later volume will continue with polyacetylene, beginning with a set of papers containing other data and reanalysis of existing data which raise questions about the relevance of the soliton picture and suggest another model. Also presented in this later volume are additional physical and chemical studies of polyacetylene, including electrochemistry and battery applications. Papers on other conducting polymers are included in this later volume, together with theoretical studies of relevance to a number of polymer systems.

The second largest group of papers, to which another volume is devoted, deals with the family of compounds $(\text{TMTSF})_2\text{X}$, where X may be PF_6 , AsF_6 , TaF_6 , SbF_6 , ClO_4 , ReO_4 , BF_4 , NO_3 , etc. All but the last two of these have been found to show superconductivity, with ClO_4 the first to do so at ambient pressure. A most interesting and controversial issue here is the range of temperatures over which superconducting fluctuations exist. Another focus of interest and controversy for these materials is provided by the large changes in conductivity observed in the semiconducting state under dc or ac fields.

In later volumes there will be a group of papers on sliding charge density waves in NbSe_3 , TaS_3 , etc., including a presentation of the tunneling theory and how well it fits the data. Groups of papers on charge density waves, conductivity and other properties, and disorder, in the context of traditional systems such as (TTF) (TCNQ) and (NMP) (TCNQ) appear in later volumes. Also included is work on inorganic platinum chain compounds and macrocyclic systems. A large number of new charge transfer salts are introduced, including work with novel donors. Many other charge transfer salts have been reexamined. New synthetic procedures are described. Methods for growing large, high quality single crystals utilizing electrochemistry are discussed.

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