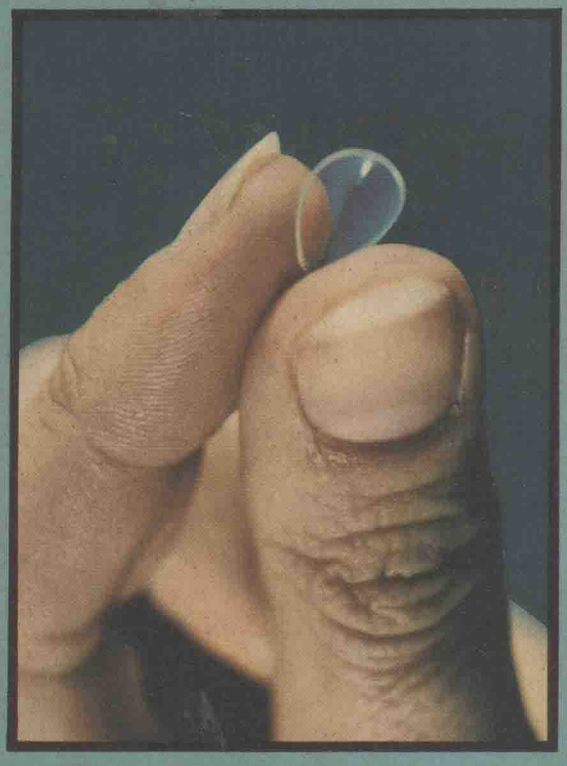

Symposium on the flexible lens

the future of flexible lenses vs. rigid lenses

Co-editors

JOSEPH L. BITONTE
RICHARD H. KEATES

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Proceedings of the Fifth Contact Lens Seminar sponsored by The Ohio State University College of Medicine, Department of Ophthalmology and Center for Continuing Medical Education, Columbus, Ohio, September, 1970

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With 103 illustrations

The C. V. Mosby Company
Saint Louis 1972

Printed in the United States of America

International Standard Book Number 0-8016-0692-6

Library of Congress Catalog Card Number 78-186449

Distributed in Great Britain by Henry Kimpton, London

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Dedicated to

The Department of Ophthalmology
The College of Medicine
The Ohio State University
Columbus, Ohio

and its chairman

Torrence A. Makley, Jr., M.D.

Preface

Interest in flexible lenses has been phenomenal in the last several years, which is evident by the response to the Fifth Contact Lens Seminar held at The Ohio State University.

Registrations included people from all parts of the United States, fourteen from Canada, four from England, three from France, one from Japan, and four from Israel.

An unofficial discussion on better terminology for *hard lenses* and *soft lenses* was brought up. The consensus was that *soft* was not very descriptive and that *flexible* would be better. *Flexible* would not become obsolete when some enterprising researcher would come up with a "softer" or "slightly harder" or "much harder" lens.

Instead of *hard lens* it was decided that *rigid lens* would be more descriptive. *Hard lens* has a poor connotation: Who wants something hard put onto his eye? Someone suggested that *stable lens* be used; however, plastic materials are not stable. This term was ruled out as misleading. Thus *rigid lens* won out.

We, the editors, have used *flexible lens* and *rigid lens* in the material prepared by us. The contributed material has been left unchanged. We hope that some standardization in terminology can be achieved, and this is our attempt to achieve it.

Many persons have contributed much to the success of this seminar and the preparation of this book. Dr. Torrence A. Makley, Jr., Chairman of the Department of Ophthalmology at The Ohio State University, was most helpful and cooperated fully with the arrangements for this seminar.

The Center for Continuing Medical Education cooperated far beyond the call of duty. They provided the closed-circuit television equipment for the live TV demonstration of the use of the flexible lens on the eye. They also provided stenographers and audiotaping for recording the proceedings of the seminar, which were used to prepare this book. Many thanks are in order for Dr. William G. Pace, Dr. Robert B. Schweikart, Dr. William B. Steis, Mr. John C. Barton, and their efficient staff.

We wish to thank especially the guest faculty, the panelists, The Ohio State

University faculty, and the contributors of the timely papers that are presented in this book.

Our special thanks also to Dr. Chester J. Black who "paid his own way to get into the seminar" and ended by presenting two papers and serving on two panels! This is the type of cooperation and enthusiasm that existed throughout the meeting.

We also wish to thank the women of the Contact Lens Section of the Department of Ophthalmology at The Ohio State University, Miss Jo Ann Glockner, Miss Susan Sellers, and Mrs. John B. Edgar, who worked diligently at the seminar, corrected and typed much of the copy for this book, and assisted in proofreading.

Joseph L. Bitonte
Richard H. Keates

Contents

PART

I

Introduction

1 Plastics for contact lenses (rigid and flexible)

Robert Leininger

Although daVinci described the precursor of the contact lens about 500 years ago, it was not until the plastic lens became available, especially in the corneal form in 1948, that the use of contact lenses became widespread. It is the purpose of this chapter to consider the structure and properties of plastics in relation to their use in contact lenses.

Plastics are members of a larger class of materials known as polymers, which include synthetic materials, such as plastics, films, adhesives, coatings, and others, as well as naturally occurring materials, such as fibers, gums, proteins, and rubber. The common features of all polymers is their high molecular weight and the fiberlike shape of their molecules. Both features are a result of the joining of relatively small molecules in a polymerization process to form giant molecules that may contain thousands of their starting units (monomers). It is the length of these macromolecules, their arrangement, and their composition that govern the properties obtained. It is because of this molecular structure that plastics have the combination of strength, transparency, formability, inertness, and the other properties that make them so suited to use as contact lenses.

Let us consider how this high molecular weight (long chain) character of polymers gives rise to the properties that make polymers of such general usefulness, and how it and the chemical composition govern the choice of polymers for contact lenses.

STRENGTH

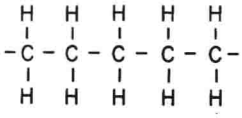
The strength of a polymer will depend primarily on the length of the component chains and the attraction between the chains. As the chain length increases, the strength increases up to a maximum. Further increases in the chain length do not yield appreciable increases in strength, but may offer improvements in prop-

Editors' note: This material was presented at the Fourth Contact Lens Seminar held on September 26 to 28, 1968, at The Ohio State University. It was very well received then, and it is the opinion of the editors that this is very timely information to use in this book.

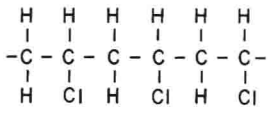
This chapter is placed first with the hope that a little understanding of polymer chemistry of the acrylics (both rigid and flexible) may make some of the following references to flexible lenses more meaningful to the readers.

erties such as fatigue and stress-crack resistance, although processing by methods such as extrusion and molding may become more difficult.

The chemical composition of a polymer is important as to strength properties because of the effect on interchain attractions. For example, polyethylene is a relatively weak material because hydrogen and carbon composition leads only to weak interchain attractions. Polyvinyl chloride is relatively strong because the substitution of chlorine atoms for hydrogen on alternate carbon atoms leads to much stronger attractive forces between molecules.

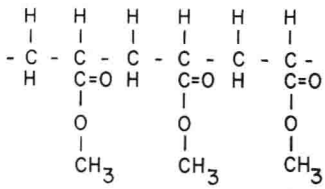


Polyethylene

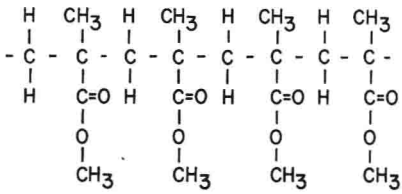


Polyvinyl chloride

Flexibility of a polymer is likewise affected by the chemical composition as shown by polymethylacrylate and polymethylmethacrylate. Polymethylacrylate is a soft, rubbery material, whereas polymethylmethacrylate is a hard, strong material by reason of the substitution of methyl groups ($-CH_3$) for hydrogen atoms on alternate carbon atoms, thus greatly increasing the rigidity of the molecule. Polymethylmethacrylate will be recognized as the common material for contact lenses.



Polymethylacrylate



Polymethylmethacrylate

There are physical procedures for increasing the strength of polymers, such as alignment of the molecules in the principal stress direction (orientation) and arrangement into ordered patterns (crystallization), that are of great importance in many applications, but are of too little importance in contact lens applications to treat here.

SOLUBILITY AND FUSIBILITY

Solubility and fusibility can be discussed at the same time because they are closely related in that both dissolution and melting involve changing the structure of a solid from one in which the molecules are fixed in position with respect to one another to a fluid form in which the molecules are relatively independent of one another in either a solution or a melt.

As stated before, polymers are composed of very long, threadlike molecules. These may be represented schematically as in Fig. 1-1. In some cases the molecules are chemically bonded at varying numbers of points as in Fig. 1-2.