Handbook of Elastomers

NEW DEVELOPMENTS AND TECHNOLOGY

edited by

Anil K. Bhowmick

Howard L. Stephens

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Preface

During the last two decades, a wealth of materials, processes, and products have been developed in the field of rubber science and engineering. The object of this book is to present a unified treatment of these developments, with special emphasis placed on the materials. Also presented here are discussions of the physical and mechanical properties of new elastomeric materials with pertinent reference made to the properties of the old. The aim of this approach is to arrive at a comprehensive understanding of the materials while providing up-to-date coverage of the field.

Of the vast amount of recent developments in elastomeric technology, we have chosen to include here only those advances that are commercially important and in current use. Emphasis is placed on scientific and technological facts and applications of the various materials available.

The chapters in this volume cover the progress of both natural and synthetic elastomers. They are contributions written by a galaxy of experts who present detailed, stimulating accounts of their topics. As far as possible, the brand names for different rubbers and chemicals have been avoided.

The book is intended for materials scientists, engineers, graduate students, and persons involved in industrial research, sales, and marketing. It is hoped that the book will serve as a useful professional reference book and a graduate textbook.

We wish to thank all the authors for their fine contributions and ready willingness to give of their time and expertise to bring this work to fruition. We are also grateful to those at the Rubber Division of the American Chemical Society, especially Mrs. Ruth Murray and Mr. R. H. Gerster, and to Professor F. N. Kelley, Director of the Institute of Polymer Science, Dr. S. L. Aggarwal of GENCORP, Dr. A. I. Medalia of Cabot Corporation, and many others for valuable information and suggestions. Special thanks are offered to Professors D. McIntyre and A. N. Gent, Mr. R. Seeger of the University of Akron, to Professors K. L. Chopra, G. S. Sanyal, S. K. De, A. Paul, A. Mookherjee, D. Sen, and B. N. Avasthi of the Indian Institute

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Guayule Rubber

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1. INTRODUCTION

1.1 Commercial Natural Rubbers

Although thousands of plant species contain rubber in small amounts, only a few species generate enough rubber to make them commercially attractive. In fact, only *Hevea brasiliensis* and guayule, *Perthenium argentatum*, have been used commercially in modern times and are likely to be used in the immediate future. Therefore in this review these two natural rubbers will be called hevea rubber and guayule rubber. Other natural rubbers will be included in the discussion to give a better perspective on the nature of natural rubbers and their prospects for future development.

1.2 Previous Reviews and Present Perspectives

There have been several previous reviews of hevea and guayule rubber. The international scientific conferences on guayule rubber are particularly interesting and relevant but have frequently included overwhelming amounts of agronomic and economic material (McGinnies and Haase, 1975; Campos-Lopez, 1978; Gregg et al., 1983). The later conferences (Guayule Rubber Society, 1983, 1984, 1985) only have abstracts and are therefore less helpful for details of research. A recent conference (International Symposium on Natural Rubber, 1980) (on hevea, guayule, and other rubbers) has some interesting comparisons of the two rubbers in the discussions. Several early authorative review articles on the whole subject of the viability and value of guayule rubber have been published (U.S. National Academy of Sciences, 1977; Campos-Lopez, 1978). A more easily accessible article on guayule rubber also recently appeared (Eagle, 1981), but it comprises an extensive literature review without either a critical evaluation of the underlying inconsistencies of different workers or an attempted synthesis of the science and technology of guayule rubber.

In this small chapter we hope to present a current critical, scientific, and technological point of view. The remarks on the agronomic and

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