Elastomers and Rubber Technology

Edited by Robert E. Singler and Catherine A. Byrne

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Elastomers and Rubber Technology

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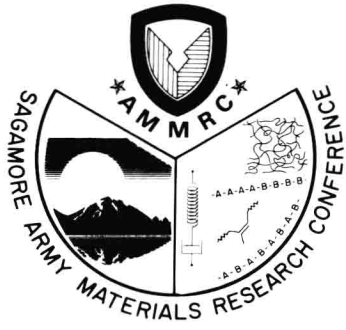

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As of October 1, 1985, the Army Materiel Command (AMC) consolidated several independent laboratories under the new Laboratory Command (LABCOM) in order to better focus the work of these laboratories within AMC. With this reorganization, the Army Materials and Mechanics Research Center (AMMRC) was renamed the U.S. Army Materials Technology Laboratory (MTL). The mission of MTL remains essentially the same as before: materials research and development for AMC and the Department of the Army.

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PREFACE

The Army Materials Technology Laboratory (formerly the Army Materials and Mechanics Research Center) has been conducting the Annual Sagamore Army Materials Research Conferences since 1954. The specific purpose of these conferences has been to bring together scientists and engineers from academic institutions, industry, and government to explore in-depth a subject of importance to the Department of Defense, the Army, and the scientific community.

The 32nd Sagamore Conference, titled "Elastomers and Rubber Technology", has attempted to focus on a major Army requirement for elastomers, namely improved tank track rubber durability. Opening remarks by Dr. Wenzel E. Davidsohn, Conference Chairman, and Dr. Robert W. Lewis, Director of Science & Technology at Natick R&D Center, highlighted the importance of rubber to the Army's mission. Presentations and posters ranged from highly theoretical to the practical engineering requirements for improving track rubber performance in field service. Exploratory polymer synthesis, characterization, elastomeric networks, polymer blends, new commercial developments, tearing and fracture of rubber, dynamic mechanical properties, mathematical modeling, laboratory and field degradation studies, were also topics at the meeting.

Other Army concerns were discussed, such as the need for improved elastomers in chemical defense applications. The banquet presentation reminded all of us that the largest single use of rubber is for automobile tires, both in the United States and abroad. Not only the Army, but modern society relies on rubber products in so many ways.

We wish to acknowledge the assistance of Ms. Karen Kaloostian of the Army Materials Technology Laboratory for all the many arrangements provided before and during the conference. Timely suggestions from Roger Beatty and the encouragement from last year's Conference Chairman

Dr. James McCauley were sincerely appreciated. We also wish to acknowledge the technical and logistical assistance of the Metals and Ceramics Information Center operated by Battelle Columbus Division, and the efforts of Aaron Friedman and Donna Blackburn of the Army MTL, Mrs. Joan Purvis of Synergic Communication Services, Inc., and Ms. Nancy Hill McClary of Battelle Columbus Division, all for assistance during the conference and in assembling these proceedings for publication.

Robert E. Singler and
Catherine A. Byrne

Watertown, MA
August, 1986

CONTENTS

SYNTHESIS AND CHARACTERIZATION OF NOVEL POLYETHER-URETHANEUREAS: "CHAIN EXTENSION" WITH TERTIARY ALCOHOLS

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INTRODUCTION

Conventional urethane elastomers are well-known to have a number of desirable properties, but are not considered high temperature polymers (1a). Continuous service applications at temperatures above 100°C are not usually recommended. Softening and even thermal dissociation of high temperatures is an inherent characteristic of the urethane linkage. However, it has been recognized that the incorporation of urea linkages in the polyurethane hard segment has a profound effect on the phase separation and domain structure of polyurethaneureas. This is largely due to the high polarity difference between hard and soft segments and possibly to the development of a three-dimensional hydrogen-bonding network.

The hard segments, in the polyurethaneurea elastomers, are often composed of an aromatic diisocyanate reacted with a diamine chain extender, while the soft segments are a low molecular weight hydroxy-terminated polyether or polyester. Due to the rapid diisocyanate reaction with diamine, solution polymerization is usually essential in the synthesis of polyurethaneurea elastomers. A relatively low polymerization temperature is necessary to prevent significant side reactions. However, the solution polymerization suffers from the difficulty of obtaining a good common solvent for both soft and hard (sometimes crystalline) segments which have a large difference in solubility parameter. Clearly, the choice of solvent affects the degree of polymerization due to premature precipitation of the polymer. A mechanically weak polymer would be obtained if the molecular weight of the segmented copolymer is low. Diamines having a substituent on the benzene ring, ortho to the amine group, such as 3,3'-dichloro-4,4'-diaminodiphenylmethane (MOCA), provide an acceptable lowered diamine reactivity in the bulk preparation of polyurethaneurea elastomers. These chain extenders, as well as derivatives of

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