MASTER COPY KEEP THIS COPY FOR REPRODUCTION PURPOSES

ENTATION PAGE

Form Approved
OMB No 0704-0188

(2)

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	2/27/93	

4. TITLE AND SUBTITLE

Fracture Behavior of Ionomers and Ionomeric Blends

5. FUNDING NUMBERS

DAAL03-89-K-0044

6. AUTHOR(S)

Masanori Hara

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Rutgers University
Department of Mechanics and Materials Science
College of Engineering
Piscataway, NJ 08855-0909

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U. S. Army Research Office
P. O. Box 12211
Research Triangle Park, NC 27709-2211

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

ARO 25424.15-MS

11. SUPPLEMENTARY NOTES

The view, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

We have elucidated the deformation/fracture behavior of ionomers, and correlated them to their microstructure. We have also found important molecular variables to achieve enhanced fracture properties of ionomers: high ion content above a critical value, divalent counterions, and excess neutralizing agent. We have elucidated the structural changes associated with the change of each molecular variable. Subsequently, we have produced unique blends made of small amounts of ionomers and large amounts of unmodified polymers. They show synergistic mechanical behavior, retention of transparency of the unmodified polymer, good processability, and excellent cost performance. We have elucidated the structural characteristics responsible for these behavior.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Deformation and Fracture Behavior, Ionomer Blends, Polystyrene Ionomer, PMMA Ionomer	2
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

FINAL REPORT

Title: Fracture Behavior of Ionomers and Ionomeric Blends

Grant Number: DAAL03-89-K-0044

A Statement of the Problem Studied

The objective of this research is to elucidate the deformation and fracture behavior of ionomers and ionomer blends in the glassy state, to correlate them to their microstructure, and to exploit the possibility of using these materials as high-performance polymers.

A Summary of the Most Important Results

Since technical materials were reported in semi-annual reports, only the most important results that we have obtained are briefly summarized here.

(1). Deformation/Fracture of Ionomers

We have found important molecular variables to achieve enhanced fracture properties (under both monotonic and dynamic loading conditions) of ionomers: these are (1) high ion content above a certain critical value (i.e., critical ion content, which depends on host polymers), (2) divalent counterions instead of monovalent ones, and (3) excess neutralizing agents. We have also elucidated the responsible structural changes for enhanced fracture properties as a result of changing molecular variable.

Specifically, we have found that the deformation mechanism of ionomers changes from crazing only to crazing plus shear deformation, either by increasing ion content or changing counterion from mono to divalent one. This is due to ionic crosslinking effect produced by ionic interactions, therefore, ionic crosslinkings can offer effective routes to modifying deformation behavior without losing processability, unlike the case of covalently crosslinked polymers.

We have proved that these are quite general findings applied to amorphous, glassy ionomers by investigating different type of ionomers: polystyrene(PS)-based ionomers (i.e., sulfonated polystyrene ionomer and styrene-co-methacrylate ionomer) and poly(methyl methacrylate)(PMMA)-based ionomers.

(2). Deformation/Fracture of Ionomer Blends

We have produced unique blends made of small amounts of ionomer and large amounts of unmodified polymers. This unique combination leads to the following advantageous properties: (1) synergistic mechanical behavior, (2) retention of transparency of the unmodified polymer, (3) excellent cost performance, and (4) good processability. We have elucidated the structural characteristics responsible for these behaviors. Again, the findings seem to be general, since we studied both PS-based blends and PMMA-based blends with basically similar results.

A List of Participating Personnel

Prof. Masanori Hara
Prof. John A. Sauer

Dr. Pean-Yue Jar
Michelle Bellinger (earned Ph.D. during the period)
Xiaolong Ma (earned Ph.D. during the period)
Jeffrey Bodycomb

A List of All Publications (Published)

"Deformation Behavior of Ionomers: Effect of Counterion and Plasticizer," Polym. Prepr., (Am. Chem. Soc., Div. Polym. Chem.), 30(2), 223 (1989)

"Effect of Molecular Variables on Crazing and Fatigue of Polymers," Adv. Polym. Sol., 91/92, 69-118 (1990)

"Fatigue Behavior of Ionomers: 2. Effect of Counterions on Sulfonated Polystyrene Ionomers," Macromolecules, 23, 4465-4469 (1990)

"Fatigue Behavior of Ionomers: 3. Effect of Excess Neutralizing Agent on Sulfonated Polystyrene Ionomers," Macromolecules, 23, 4964-4969 (1990)

"Deformation and Fracture of Ionomeric Blends: Sulfonated Polystyrene Ionomer/Polystyrene," Polym. Prepr., (Am. Chem. Soc., Div. Polym. Chem.), 31(1), 546 (1990)

"Effect of Sample History on Ionic Aggregate Structure of Sulfonated Polystyrene Ionomers," Polymer, 32, 1380-1383 (1991)

"Blends of Sulfonated Polystyrene and Polystyrene: Morphology and Deformation Modes," Polymer International, 26, 137-141 (1991)

"Deformation Modes and Morphology in PS/Sulphonated PS Ionomer Blends," Preprints, IUPAC International Symposium Polymer 91, p. 222 (1991)

"Dynamic Mechanical Properties of Sulfonated Polystyrene Ionomers," Polymer, 32, 1622-1626 (1991)

"Deformation/Fracture Behavior of Ionomer Blends," Proceedings of 8th International Conference on Deformation, Yield, and Fracture of Polymers, Paper No.35 (1991)

"Deformation and Fracture of Sulfonated Polystyrene Ionomer/Polystyrene Blends: Effect of Ion Content," Polym. Prepr., (Am. Chem. Soc., Div. Polym. Chem.), 32(3), 261 (1991)

"Deformation and Fracture Behavior of Polystyrene Ionomer and Ionomer Blends," Colloid Polymer Science, 270, 652-658 (1992)

"PMMA-based Ionomers. I. Dynamic Mechanical Properties," Polym Prepr., (Am. Chem. Soc., Div. Polym. Chem.), 33(1), 1214 (1992)