

AD-A209 428

ARO 22303.8-MS

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A New Method for Monitoring Cure and Mobility in
Epoxy Matrix and Fiber/Epoxy Interphases

Final Report

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March 28, 1989

U.S. Army Research Office

Contract Number: DAAG29-85-K-0055

Institute of Materials Science, U-136

University of Connecticut

Storrs, CT 06269-3136

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SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified		1b. RESTRICTIVE MARKINGS	
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.	
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE		4. PERFORMING ORGANIZATION REPORT NUMBER(S) Final Report	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Final Report		5. MONITORING ORGANIZATION REPORT NUMBER(S) ARO 22303.8-MS	
6a. NAME OF PERFORMING ORGANIZATION University of Connecticut	6b. OFFICE SYMBOL (if applicable) IMS	7a. NAME OF MONITORING ORGANIZATION U. S. Army Research Office	
6c. ADDRESS (City, State, and ZIP Code) Institute Of Materials Science 97 N. Eagleville Rd. Storrs, CT 06269-3136		7b. ADDRESS (City, State, and ZIP Code) P. O. Box 12211 Research Triangle Park, NC 27709-2211	
8a. NAME OF FUNDING/SPONSORING ORGANIZATION U. S. Army Research Office	8b. OFFICE SYMBOL (if applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER DAAG-29-85-15-0055	
8c. ADDRESS (City, State, and ZIP Code) P. O. Box 12211 Research Triangle Park, NC 27709-2211		10. SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO.	PROJECT NO.
		TASK NO.	WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) A New Method for Monitoring Cure and Mobility in Epoxy Matrix and Fiber/Epoxy Interphases			
12. PERSONAL AUTHOR(S) C.S.P. Sung			
13a. TYPE OF REPORT Final	13b. TIME COVERED FROM 3-15-85 TO 12-14-89	14. DATE OF REPORT (Year, Month, Day) March 28, 1989	15. PAGE COUNT
16. SUPPLEMENTARY NOTATION 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.			
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	
		Cure Monitoring, UV-VIS and Fluorescence Spectroscopy, Epoxy, Polyimide, Polyurethane, Polyamide, Reactive Labelling	
19. ABSTRACT (Continue on reverse if necessary and identify by block number) The objective of this contract was to develop a new method based on reactive labeling technique for monitoring cure and mobility in epoxy matrix and fiber/epoxy interphases. These reactive labels were chosen to exhibit spectral changes in the region of UV-visible and fluorescence spectra where the polymerizing matrix has little absorption or emission. In this method, we take advantage of the magnified effects of the substituent changes in the para and para- positions of conjugated aromatic reactive labels on the UV-visible and fluorescence spectra. We have applied this method to characterize the kinetics and mechanisms of the cure in epoxy networks and in polyurethanes, the imidization process in polyimides, and the acylation in polyamides. One particular advantage of this method is that we can often distinguish between several cure species in some polymers. This advantage makes it possible to follow cure composition throughout the cure process and to analyze the kinetics and the mechanisms of several consecutive polymerization steps in some polymers.			
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL		22b. TELEPHONE (Include Area Code)	22c. OFFICE SYMBOL

A U.S. patent (No. 4,714,674) has been granted in Jan., 1988 for monitoring cure in epoxy networks. Another U.S. patent to cover applications in polyimides and polyurethanes is pending. The following is a list of publications and student theses completed during the period of the contract.

(A) Student Thesis

1. E. Pyun, Ph.D. Thesis, Aug. 1988, "Characterization of Epoxy and Polyimide Cure by UV-Visible and Fluorescence Spectroscopy; Azochromophoric Labeling Approach"
2. W.C. Yu, Ph.D. Thesis, May, 1988, "Azochromophoric Photochemical and Photophysical Tools for the Study of Physical Aging and Epoxy Cure"
3. R. Mathisen, M.S. Thesis, May, 1987, "Development and Application of the Reactive Labeling Technique for Monitoring the Cure of Polyimides"
4. X.Y. Huang, M.S. thesis, Jan. 1989, "Monitoring the Cure of Polyurethane by UV Absorption and Fluorescence Spectroscopy"

(B) Publications

1. C.S.P. Sung, I.J. Chin and W.C. Yu, "A Novel Fluorescence Technique for Monitoring Cure Reactions in Epoxy Networks", *Macromolecules*, 18, 1510, 1985.
2. C.S.P. Sung, "UV-Visible and Fluorescence Characterization of Epoxy Network Polymers Using Chromophore Labelling", *Proceedings of 2nd Japan-US Polymer Symposium*, 283, 1985.
3. C.S.P. Sung and E. Pyun, "Studies on Cure Kinetics and Mobility in Epoxy Network by Azochromophore Labelling Technique", *ACS Polymer Preprints*, 27-1, 78, 1986.
4. C.S.P. Sung, E. Pyun and H.-L. Sun, *Macromolecules*, 19, 2922, 1986.
5. C.S.P. Sung, R. Mathisen and C. Filardi, "Cure Characterization of an Epoxy Network by Trans Diamino-Stilbene Labelling", *ACS Polymers Preprints*, 27-2, 308, 1986.
6. C.S.P. Sung and R. Mathisen, "Characterization of Cure in an Epoxy Network by Fluorescence of trans Diamino-Stilbene Labelling", *Polymer*, 28, 941, 1987.
7. R.J. Mathisen, J.K. Yoo and C.S.P. Sung, "A Dye Labelling Technique for Monitoring Cure of Polyimides and Polyureas; Model Compound Studies", *Macromolecules*, 20, 1414, 1987.
8. C.S.P. Sung, "Application of Reactive Dye Labelling Technique for Cure Characterization of Epoxy Networks," *ACS Symposium Series on Photophysics of Polymer*, Ed. by C.E. Hoyle and J.M. Torkelson, ACS, Washington, 463, 1987.
9. R. Mathisen and C.S.P. Sung, "Imidization Studies of Polyamic Acids by Dye Labelling Technique, *ACS Polymer Preprints*, 28-1, 82, 1987.
10. W.C. Yu and C.S.P. Sung, "Mobility and the Distribution of Free Volume in Epoxy Network by Photochromic Labelling and Probe Studies", *Macromolecules*, 21, 365, 1988.
11. W.C. Yu, C.S.P. Sung and R.E. Robertson, "Site-Specific Labelling and the Distribution of Free Volume in Glassy Polystyrene", *Macromolecules*, 21, 355, 1988.
12. E. Pyun, R. Mathisen and C.S.P. Sung, "Kinetics and Mechanisms of Imidization of a Polyamic Acid Studied by UV-Vis Spectroscopy", *Macromolecules*, 22, 1174, 1989.

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