

**Examination of the Aging Properties of Novel Cyanate Ester
Thermosets and the Subsequent Evaluation of the Material
under Application Conditions**

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(ABSTRACT)

Cyanate ester thermosetting resins are a novel family of materials for high technology and aerospace applications. The high glass transition temperatures available from cured cyanate ester networks and subsequently, their resistances to corrosive materials make these resins attractive for harsh environmental applications. These features of cyanate ester resins presented a threefold opportunity for investigation, namely: 1) establish a characterization technique for the long term mechanical properties of the cured resins, 2) develop a method for determining the effect of physical and chemical aging on these mechanical properties, and 3) evaluate the AroCy[®] B-10 cyanate ester resin from Ciba-Geigy for use in applications where temperatures could easily reach 177°C (300°F).

Dynamic mechanical analysis used in a step isothermal mode was developed to characterize the mechanical properties of the cured resin and a family of isothermal modulus curves was established. These data were then shifted, following WLF theory, to create a master curve of storage modulus with respect

to measurement frequency. The resultant master curves allowed the prediction of long term mechanical behavior of the resin networks via short duration, accelerated experimental tests. The test methodology and experimental procedures were especially useful in determining the effects of physical and chemical aging on the mechanical properties of the resin.

Cured resins were aged in oxidative and inert atmospheres (air and nitrogen, respectively) for varying time and temperature to study the suitability of cyanate ester resins for harsh environmental applications. After aging, the samples were tested by DMA, DSC and TGA and master curves of their mechanical behavior were generated. The results were then grouped to form a family of master curves as a function of atmosphere, time and temperature. This approach allowed for the separation of the competing chemical and physical degradation processes and established the practical application conditions for this class of cross-linked polymers.

Using the techniques established above, a model cyanate ester resin was selected based upon its chemical simplicity and availability. AroCy[®] B-10 cyanate ester resin manufactured commercially by Ciba-Geigy was evaluated for its application where temperatures could easily reach 177C. While this material was clearly unacceptable for the stated application conditions (especially in an oxygen rich atmosphere), its investigation provided experimental confirmation of the techniques developed. The test procedures and performance evaluation

techniques described allow for the systematic assessment of not only the cyanate ester class of networking polymers, but any glass forming material, and a separation methodology for their concomitant chemical and physical degradation pathways.

DEDICATION

This dissertation is dedicated to my grandmother Serina White 1907 - 1993.

She was truly an inspiration both as a grandmother and a woman. I will always carry my memories of her close to my heart and never let her be forgotten.

VERSE: ROMANS 5:9

**“Much more then, being now justified by his blood,
We shall be saved from wrath through him.”**

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Table of Contents

ABSTRACT	-----	ii
DEDICATION	-----	v
ACKNOWLEDGMENTS	-----	vi
TABLE OF CONTENTS	-----	ix
LIST OF FIGURES	-----	xiii
LIST OF TABLES	-----	xxiii

CHAPTER 1

1.0 INTRODUCTION	-----	1
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CHAPTER 2

2.0 BACKGROUND AND LITERATURE REVIEW	-----	4
2.1 INTRODUCTION	-----	4
2.2 CYANATE ESTERS	-----	7
2.2.1 Introduction	-----	7
2.2.2 Reactions of Cyanate Esters	-----	9
2.2.3 Cyanate Ester Resin Networks	-----	13
2.3 PHYSICAL AGING	-----	27
2.3.1 Introduction	-----	27
2.3.2 Glass Transition and the Glassy State	-----	28
2.3.2a Free Volume Theory	-----	28

2.3.2b	Thermodynamic Theory	36
2.3.3	Physical Aging and Nonequilibrium Behavior	38
2.3.4	Methods of Detecting and Measuring Physical Aging	48
2.4	CHEMICAL AGING	54
2.4.1	Introduction	54
2.4.2	Kinetics of Chemical Aging	55
2.4.3	Mechanisms of Chemical Aging	61
2.4.3a	Oxidation	62
2.4.3b	Hydrolysis	64
2.4.4	Methods of Detecting and Measuring Chemical Aging	66
CHAPTER 3		
3.0	EXPERIMENTAL METHODS AND TEST PROCEDURES	71
3.1	INTRODUCTION	71
3.2	SYNTHESIS AND FORMULATION OF CYANATE ESTERS	72
3.2.1	Material Information	72
3.2.2	Neat Resin	75
3.2.3	Toughened Resin	79
3.3	AGING PROFILES	82
3.4	INSTRUMENTATION	84
3.4.1	Mechanical Analyses	84
3.4.2	Thermal Gravimetric Analyses	88
3.4.3	Modulated Differential Scanning Calorimetry (MDSC)	89
3.5	SUMMARY OF EXPERIMENTAL DATA	90

CHAPTER 4

4.0	RESULTS AND DISCUSSION	94
4.1	INTRODUCTION	94
4.2	MASTER CURVE DEVELOPMENT	96
4.3	AGING ANALYSES	103
4.3.1	Quench / Annealing Study	103
4.3.2	Aging In Nitrogen	114
4.3.2a	260°C Aging Study, Neat Resin	114
4.3.2b	177°C Aging Study	123
4.3.3	Aging In Air	133
4.3.3a	177°C Aging Study	133
4.3.3a.1	Neat Resin	133
4.3.3a.2	Thermoplastic Toughened Resin	148
4.3.3b	260°C Aging Study, Neat Resin	160

CHAPTER 5

5.0	CONCLUSIONS	168
-----	-------------	-----

CHAPTER 6

6.0	REFERENCES	173
-----	------------	-----

APPENDIX A

DEVELOPMENT OF A NOVEL METHOD FOR THE BUILDING OF TTT CURE DIAGRAMS I -- DYNAMIC MECHANICAL THERMAL ANALYSIS

A.1	LITERATURE REVIEW	185
A.1.1	TTT diagrams - Theory and Development	185
A.1.2	Effects of Toughening on Thermosetting Materials	192
A.2	EXPERIMENTAL METHODS AND TEST PROCEDURES	196
A.3	RESULTS AND DISCUSSION	199
A.3.1	Initial Bending Mode Experiments	199
A.3.2	Shear Mode Experiments	204
A.3.3	Experimental Alternatives	208
A.4	SUMMARY	212
A.5	REFERENCES	212

APPENDIX B

DEVELOPMENT OF MEASUREMENT METHODS FOR CURE PROPERTIES USING REMOTE SENSING DIELECTRIC THERMAL ANALYSIS

B.1	LITERATURE REVIEW	215
B.1.1	Introduction	215
B.1.2	Remote Sensing Dielectric Analysis	216
B.2	EXPERIMENTAL METHODS AND TEST PROCEDURES	223
B.3	RESULTS AND DISCUSSION	224
B.4	SUMMARY & CONCLUSIONS	234
B.5	REFERENCES	236

List of Figures

CHAPTER 2

- Figure 2-1.** Simple model of a liquid showing occupied and free volume.⁽⁷²⁾ **29**
- Figure 2-2.** Total and occupied volumes of a glass forming liquid as a function of temperature.⁽⁷²⁾ **30**
- Figure 2-3.** Illustration of the free-volume concept and its application to the aging problem.⁽⁷⁰⁾ **40**
a.) Segmental mobility vs. volume
b.) Free volume and segmental mobility vs. temperature
- Figure 2-4.** Small strain tensile creep curves of rigid PVC quenched from 90°C to 40°C and annealed at 40°C.^(69,70) **42**
- Figure 2-5.** The shift rate, μ , vs. temperature for various polymers.⁽⁷⁰⁾ **47**
- Figure 2-6.** a) Changing heat capacity with aging. **50**
b) Extent of aging at 12.6 K below T_g .⁽¹⁰²⁾
- Figure 2-7.** Luminescence emission from aramid films at 77K: poly (m-phenylene 1,3-phthalamide). **68**
a.) Irradiated at >310nm under vacuum for 0 h (---), 20 h (-•-), and 100 h (—);
b.) Comparative samples containing 2-aminobenzophenone: —, unirradiated film (0.025 M) -----, 2-propanol solution.⁽¹⁵⁷⁾

CHAPTER 3

- Figure 3-1.** Scanning electron microscopy (SEM) comparison of two morphologies controlled by cure cycle. **81**
a) low temperature cure.
b) high temperature cure.
- Figure 3-2.** Schematic representation of single cantilever bending mode DMTA **85**

- Figure 3-3.** Typical raw data collected for master curve development. **87**
 (5 days aged @ 177° C in Air)
 a.) Storage modulus, E' vs. temperature
 b.) Storage modulus, E' vs. frequency

CHAPTER 4

- Figure 4-1.** Set of isothermal curves developed from DMA in step-isothermal mode. Data collected from unmodified cyanate ester resin aged for five days in an air atmosphere. **97**
- Figure 4-2** Representation of master curve data produced from time-temperature superposition. **99**
 a.) Master curve of storage modulus (E')
 b.) Resultant shift factor plot
- Figure 4-3** Other viscoelastic property master curves generated using the same shift factors, a_T **101**
 a.) Master curve of loss modulus (E'')
 b.) Master curve of $\tan \delta$ (E''/E')
- Figure 4-4** Family of master curves developed for neat cyanate ester resins at 177°C. The samples were aged in an air atmosphere for the times shown. **102**
- Figure 4-5** Shift factor plot data against reduced temperature. Data corresponds to master curves in Figure 4-4. WLF model calculated using universal constants. **104**
- Figure 4-6** Bending storage modulus master curves of neat cyanate ester resins. A comparison of quench cooled verses annealed (slow cooled) samples. Samples were prepared in an air atmosphere; mechanical testing was performed under nitrogen. **106**
- Figure 4-7** Bending $\tan \delta$ master curves of neat cyanate ester resins. A comparison of quench cooled verses annealed (slow cooled) samples. Samples were prepared in an air atmosphere; mechanical testing was performed under nitrogen. **107**

Figure 4-8	Shift factor plot generated corresponding to the master curves in Figure 4-6 and Figure 4-7.	108
Figure 4-9	Mechanical data displayed as a function of temperature for the quenched and annealed samples. Samples were prepared in an air atmosphere; mechanical testing was performed under nitrogen. a.) Storage modulus data b.) Tan δ data	110
Figure 4-10	Mechanical data displayed as a function of temperature for the quenched, intermediate and annealed samples. Samples were prepared in an air atmosphere; mechanical testing was performed under nitrogen. a.) Storage modulus data b.) Tan δ data	112
Figure 4-11	Bending storage modulus master curves of neat cyanate ester resins. A comparison of samples aged in nitrogen at 260°C for varying amounts of time.	115
Figure 4-12	Bending tan δ master curves of neat cyanate ester resins. A comparison of samples aged in nitrogen at 260°C for varying time.	116
Figure 4-13	Shift factor plot generated corresponding to the master curves in Figure 4-11 and Figure 4-12.	117
Figure 4-14	Mechanical data displayed as a function of temperature for neat cyanate ester resins aged in nitrogen at 260°C. a.) Storage modulus data b.) Tan δ data	119
Figure 4-15	Visual examination of neat cyanate ester resins aged at 260°C. Photographs of actual samples are displayed a.) Materials aged in a nitrogen atmosphere b.) Materials aged in an air atmosphere	120
Figure 4-16	TGA comparison of neat cyanate ester resins aged at 260°C. Thermal sweeps performed in air at 10°C/min. a.) Nitrogen aged samples b.) air aged samples	122

Figure 4-17	TGA comparison of neat cyanate ester resins aged at 260°C. Thermal sweeps performed in nitrogen at 10°C/min. a.) Nitrogen aged samples b.) Air Aged Samples	124
Figure 4-18	Storage modulus master curves for cyanate ester resin aged in a nitrogen atmosphere at 177°C for times shown.	126
Figure 4-19	Tangent δ master curves for cyanate ester resins aged in a nitrogen atmosphere at 177°C for times shown.	127
Figure 4-20	Shift factor plots for cyanate ester resins aged in a nitrogen atmosphere at 177°C for times shown.	128
Figure 4-21	Rearranged data at a frequency of 1 Hz for examination on the temperature axis a.) Storage modulus, E' b.) $\tan \delta$	129
Figure 4-22	Storage modulus master curves and shift factor plots (less 10 days aged) for cyanate ester resin aged in a nitrogen atmosphere at 177°C for times shown.	130
Figure 4-23	Tan δ master curves (less 10 days aged) for cyanate ester resin aged in a nitrogen atmosphere at 177°C for times shown.	131
Figure 4-24	Continuous sweep thermal scans of 5 and 50 day aged samples at a frequency of 1 Hz. a.) Storage modulus, E' b.) $\tan \delta$	132
Figure 4-25	Storage modulus master curves for neat cyanate ester resin aged in an air atmosphere at 177°C for times shown. Cure schedule was one hour at 150°C and two hours at 250°C as a post-cure.	135
Figure 4-26	Tangent δ master curves for neat cyanate ester resins aged in an air atmosphere at 177°C for times shown. Cure schedule was one hour at 150°C and two hours at 250°C as a post-cure.	136

Figure 4-27	Shift factor plots for neat cyanate ester resins aged in an air atmosphere at 177°C for times shown. These plots correspond to the master curves displayed in Figure 4-25 and Figure 4-26.	138
Figure 4-28	Rearranged data at a frequency of 1 Hz for examination on the temperature axis a.) Storage modulus, E' b.) tan δ	139
Figure 4-29	Visual examination of neat cyanate ester resins after aging at 177°C for the displayed time in the corresponding atmosphere a.) Air aged samples b.) Nitrogen aged samples	140
Figure 4-30	Modulated DSC scans of neat cyanate ester resin samples aged in an air atmosphere at 177°C for the times shown. Cure schedule was one hour at 150°C and two hours at 250°C as a post-cure. T _g was determined using the TA Universal Analysis Software. The midpoint of change in the reversible heat flow was used as the measured value.	142
Figure 4-31	Storage modulus master curves for neat cyanate ester resin aged in an air atmosphere at 177°C for times shown. Cure schedule was three hours at 250°C.	143
Figure 4-32	Tangent δ master curves for neat cyanate ester resins aged in an air atmosphere at 177°C for times shown. Cure schedule was three hours at 250°C.	144
Figure 4-33	Shift factor plots for neat cyanate ester resins aged in an air atmosphere at 177°C for times shown. These plots correspond to the master curves displayed in Figure 4-30 and Figure 4-31.	145
Figure 4-34	Rearranged data at a frequency of 1 Hz for examination on the temperature axis a.) Storage modulus, E' b.) tan δ	146

Figure 4-35	Modulated DSC scans of neat cyanate ester resin samples aged in an air atmosphere at 177°C for the times shown. Cure schedule was three hours at 250°C. T_g was determined using the TA Universal Analysis Software. The midpoint of change in the reversible heat flow was used as the measured value.	147
Figure 4-36	Storage modulus master curves for 25% thermoplastic toughened cyanate ester resins aged in an air atmosphere at 177°C for times shown. Cure schedule is also displayed.	149
Figure 4-37	Tangent δ master curves for 25% thermoplastic toughened cyanate ester resins aged in an air atmosphere at 177°C for times shown. Cure schedule is also displayed.	150
Figure 4-38	Shift factor plots for 25% thermoplastic toughened cyanate ester resins aged in an air atmosphere at 177°C for times shown.	151
Figure 4-39	Rearranged data for 25% thermoplastic toughened cyanate ester resins aged in an air atmosphere at 177°C for times shown. Data at a frequency of 1 Hz is represented for examination on the temperature axis. a.) Storage modulus, E' b.) $\tan \delta$	152
Figure 4-40	Modulated DSC scans of 25% thermoplastic toughened cyanate ester resin samples aged in an air atmosphere at 177°C for the times shown. Cure schedule was one hour at 150°C and two hours at 250°C as a post-cure. T_g was determined using the TA Universal Analysis Software. The midpoint of change in the reversible heat flow was used as the measured value.	153
Figure 4-41	Storage modulus master curves for 25% thermoplastic toughened cyanate ester resins aged in an air atmosphere at 177°C for times shown. Cure schedule is also displayed.	155
Figure 4-42	Tangent δ master curves for 25% thermoplastic toughened cyanate ester resins aged in an air atmosphere at 177°C for times shown. Cure schedule is also displayed.	156

Figure 4-43	Shift factor plots for 25% thermoplastic toughened cyanate ester resins aged in an air atmosphere at 177°C for times shown.	157
Figure 4-44	Rearranged mechanical data at a frequency of 1 Hz for examination on the temperature axis a.) Storage modulus, E' b.) tan δ	158
Figure 4-45	Modulated DSC scans of 25% thermoplastic toughened cyanate ester resin samples aged in an air atmosphere at 177°C for the times shown. Cure schedule was three hours at 250°C. T _g was determined using the TA Universal Analysis Software. The midpoint of change in the reversible heat flow was used as the measured value.	159
Figure 4-46	Visual Examination of neat cyanate ester resins aged at 260°C. Photographs of actual samples are displayed A. Materials aged in a nitrogen atmosphere B. Materials aged in an air atmosphere	161
Figure 4-47	Modulated DSC scans of neat cyanate ester resin samples aged in an air atmosphere at 260°C for the times shown. No discernable T _g observed.	163
Figure 4-48	Modulated DSC scans of neat cyanate ester resin samples aged in a nitrogen atmosphere at 260°C for the times shown. T _g was determined using the TA Universal Analysis Software. The midpoint of change in the reversible heat flow was used as the measured value.	164
Figure 4-49	TGA thermal traces in air of neat cyanate ester resins aged at 260°C for times shown. A. Aged in nitrogen B. Aged in air	165
Figure 4-50	Expanded view of TGA thermal traces performed in air of neat cyanate ester resin samples aged in air at 260°C for times shown.	167

APPENDIX A

Figure A-1.	Time-Temperature-Transformation (TTT) isothermal cure diagram for a thermosetting system. ^(A2)	186
Figure A-2.	Isothermal Torsional Braid Analysis Spectra ^(A8) a.) Relative Rigidity b.) Log Decrement	190
Figure A-3.	Phase diagrams in terms of temperature, number of repeat units, and interaction parameter. ^(A24)	193
Figure A-4.	Morphologies resulting from spinodal decomposition. ^(A25) a.) Co-continuous phase morphology b.) Beginning stages of micro-phase formation, white phase dominant c.) Micro-phase structure, white phase is continuous d.) Beginning stages of micro-phase formation, black phase dominant e.) Micro-phase structure, black phase is continuous	194
Figure A-5.	a.) Single cantilever bending mode sample arrangement. b.) Shear sandwich arrangement.	198
Figure A-6.	150°C isothermal DMA measurement in bending mode of the cure of neat cyanate ester resin. Data were collected at an applied frequency of 1 Hz.	200
Figure A-7.	Isothermal melt viscosity (Pa*s) as a function of time (min) of the neat resin (NR) and the 25% toughened resin (TR). ^(A27)	202
Figure A-8.	Comparison of isothermal cure temperature on the cure properties. Shear mode DMTA	205
Figure A-9.	Comparison of isothermal cure temperature data for 25% toughened cyanate ester	207
Figure A-10.	An attempt at reproducibility in shear mode experiments. Isothermal cure temperature was 160°C for all experiments.	209

Figure A-11.	An attempt to reproduce isothermal cure data in the protected bending mode. Isothermal cure temperature was 150°C.	211
 APPENDIX B		
Figure B-1.	Schematic representation of a dielectric remote sensor. ^(B-14)	217
Figure B-2.	Representation of applied voltage and current response. ^(B-24)	218
Figure B-3.	Representation of dielectric cure data for 140°C isothermally cured unmodified cyanate ester. Three frequencies were used to obtain the data. a.) Dielectric constant vs. time b.) Tan δ vs. time	225
Figure B-4.	Dipolar component to complex dielectric constant. Expanded Y-axis. a.) Dielectric constant vs. time b.) Tan δ vs. time	227
Figure B-5.	Comparison of cure temperature on dielectric properties of an unmodified cyanate ester. Two frequency extremes represented. a.) 1 kHz b.) 100 kHz	229
Figure B-6.	Y-axis expansion of Figure B-5. Dipolar component comparison a.) 1 kHz b.) 100 kHz	230
Figure B-7.	Comparison of dielectric constant during cure of unmodified and modified cyanate ester resins. a.) Neat resin b.) 25% Thermoplastic toughened resin	232
Figure B-8.	Comparison of dielectric tan δ during cure of unmodified and modified cyanate ester resins. a.) Neat resin	233

b.) 25% thermoplastic toughened resin

Figure B-9. Expansion of $\tan \delta$ axis to observe vitrification peak. **235**
Comparison of unmodified and modified cyanate ester.
a.) Neat Resin
b.) 25% thermoplastic toughened resin

List of Tables

CHAPTER 2

Table 2-1.	Commercially Available Dicyanate Monomers from Ciba-Geigy, Inc. and Dow Chemical Company	15
Table 2-2.	Novel Dicyanate Monomers Reported by Abed and McGrath. ⁽²⁸⁻²⁹⁾	18
Table 3-1.	Quench / Annealing Study Data Summary	90
Table 3-2.	260°C Aging Study Data Summary	91
Table 3-3.	177°C Aging Study Data Summary	92
Table A-1	Gel point determination from isothermal melt viscosity data. ^(A27)	203