REPORT DOCUMENTATION PAGE

AFRL-SR-BL-TR-02-
0156

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. F
	25 Mar 02	FINAL REPORT 01 Jul 99 To 30 Jun 01

4. TITLE AND SUBTITLE	5. FUNDING NUMBERS
ADVANCED ORGANAIC ELECTRO-OPTIC MATERIALS FOR INTEGERATED DEVIC APPLICATIONS	F49620-99-1-0287 1651/05 62173C
6. AUTHOR(S) Dr Larry D. Dalton	

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
University of Washington Department of Chemistry Box 351700 Seattle, WA 98195-1700	

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSORING/MONITORING AGENCY REPORT NUMBER
AFOSR/NL 801 N. Randolph Street, Room 732 Arlington, VA 22203-1977	

20021231 139

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Electro-optic chromophores (FTC and CLD) were synthesized in bulk (kilogram) quantities and were distributed to the participants of this program project (Steier, Fetterman, Chen, and TACAN/IPITEK). They were also provided to other Department of Defense programs including to researchers at China Lake (Navy), Redstone Arsenal (Army), and Wright Paterson (Air Force Research Laboratory) and to various industrial programs (e.g., Lockheed Martin) participating in DoD research programs. FTC and CLD chromophores were systematically modified to improve their properties, including for lattice hardening to stabilize electro-optic activity for operation at elevated temperatures and photon flux levels. Over 100 variants of these chromophores were synthesized and were evaluated. Reaction yields were optimized by systematically variation of reaction conditions. New chromophores were also synthesized at the University of Washington including those involving incorporation of significantly improved chromophores. These new materials involve factors of 1.5-2.0 improvement over FTC and CLD chromophores in terms of electro-optic activity at telecommunication wavelengths. They also have proven more amendable to being processed into hardened material lattices and have exhibited significantly improved thermal and photochemical stability. The role of chromophore structure and the use of radical (and singlet oxygen) scavengers have been investigated. The results can be utilized to fabricate materials with significantly improved photochemical stability.

14. SUBJECT TERMS	15. NUMBER OF PAGES
	16. PRICE CODE

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

Advanced Organic Electro-Optic Materials for Integrated Device Applications

Final Report

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Abstract

Electro-optic chromophores (FTC and CLD) were synthesized in bulk (kilogram) quantities and were distributed to the participants of this program project (Steier, Fetterman, Chen, and TACAN/IPITEK). They were also provided to other Department of Defense programs including to researchers at China Lake (Navy), Redstone Arsenal (Army), and Wright Paterson (Air Force Research Laboratory) and to various industrial programs (e.g., Lockheed Martin) participating in DoD research programs.

FTC and CLD chromophores were systematically modified to improve their properties, including for lattice hardening to stabilize electro-optic activity for operation at elevated temperatures and photon flux levels. Over 100 variants of these chromophores were synthesized and were evaluated. Reaction yields were optimized by systematically variation of reaction conditions. New chromophores were also synthesized at the University of Washington including those involving incorporation of significantly improved chromophores. These new materials involve factors of 1.5-2.0 improvement over FTC and CLD chromophores in terms of electro-optic activity at telecommunication wavelengths. They also have proven more amendable to being processed into hardened material lattices and have exhibited significantly improved thermal and photochemical stability.

The role of chromophore structure and the use of radical (and singlet oxygen) scavengers have been investigated. The results can be utilized to fabricate materials with significantly improved photochemical stability.

Progress Report

The use of the CLD chromophore for device fabrication and evaluation is discussed extensively in the accompanying Steier report and will not be reproduced here. The development of crosslinkable versions of the CLD chromophore is described in References 26 and 36. In these references, we also report the first systematic study of the photostability of polymeric electro-optic materials at telecommunication wavelengths. The dominant decomposition mechanism is shown to involve singlet oxygen. Maintenance of an argon rich atmosphere above polymeric electro-optic modulators results in dramatic improvement in the stability of electro-optic activity as is shown in the accompanying figure. Photostability is also enhanced by use of singlet oxygen scavengers and by lattice hardening (which reduces oxygen diffusion rates).

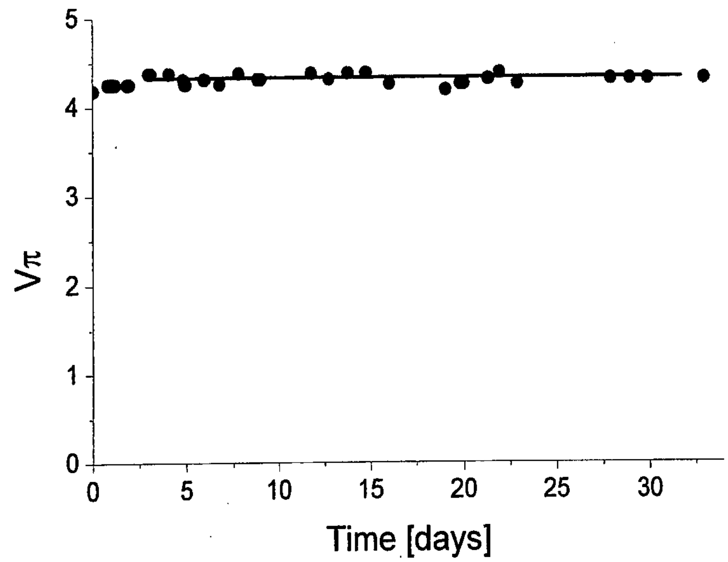

Figure 1. Drive voltage photostability recorded for 20 mW output power at 1.55 microns wavelength.

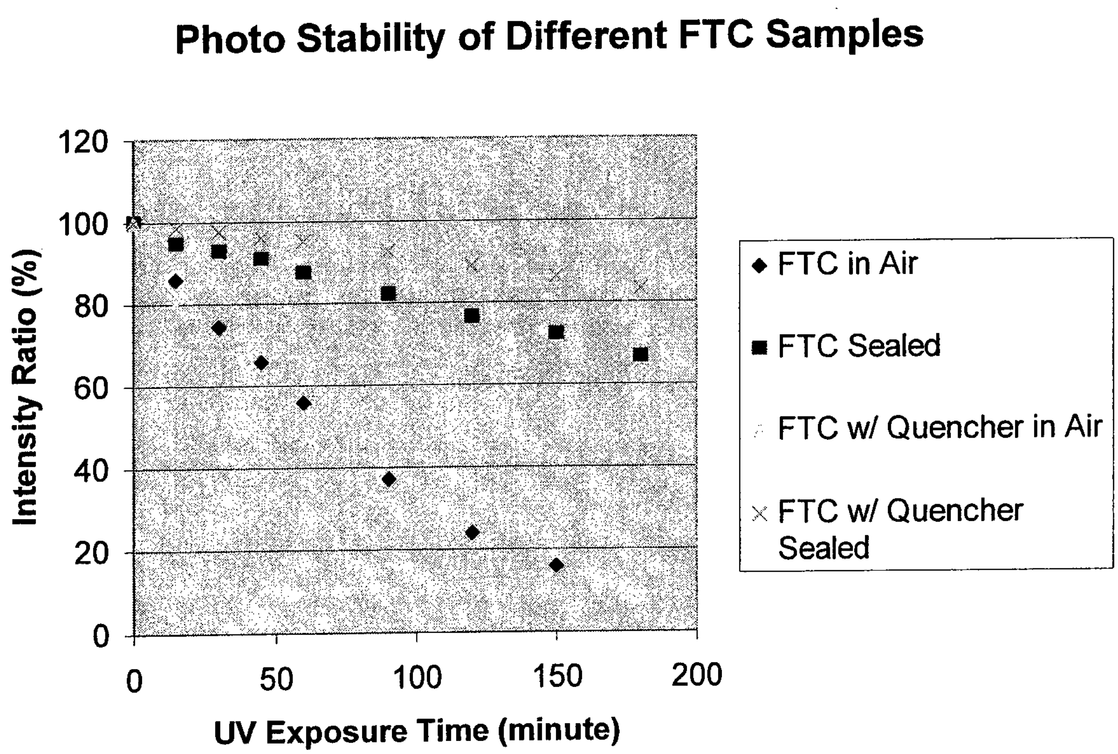

Figure 2. The effect of addition of quenchers on the photostability of FTC is shown. The measurements are for irradiation of a sample with a 400 watt lamp (directly into the interband

transition). The quencher results in some plasticization of the host lattice, which accounts for the acceleration of the photodegradation rate in the presence of air (excess oxygen).

Similar results have been realized for CLD-type chromophores in PMMA and APC host matrices. Moreover, we have examined a wide range of quenchers and have found substantial variability for different quenchers. It is clear that significant improvement in photostability can be achieved by exploiting the our finding during the past contract period.

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