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Fifth Quarterly Technical Report

Analysis and Evaluation of Technical Data
on the
Photochromic and Non-Linear Optical
Properties of Materials

March 15, 1990

George Mason University

Robert F. Cozzens, Principal Investigator

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Contract #: DAAB07-89-F404
Project #: CJ829178CJCA
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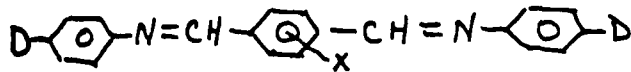
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BACKGROUND

The principle goal of this relatively small contractual effort is to provide technical assistance to DARPA in evaluating data on materials, especially polymers, that may be useful in the development of limiters and switches for the protection of eyes and electro-optic sensors from exposure to damaging levels of laser radiation. A principle task is to assist in the development of a predicative capability in assessing the viability of various approaches and devices and to assess theoretical limitations in the use of organic materials as optical switches and limiters. In addition, the Principal Investigator was appointed by Dr. Frank Patten (DARPA), the former manager of this technical program, to be part of an ad hoc Technical Advisory Committee. This Committee has not met during this quarter. >(AB)

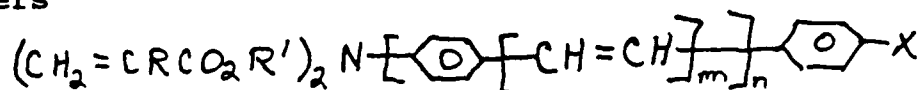
PROGRESS TO DATE

The second quarterly report 31 May 1989 had appended to it an exhaustive survey of the literature listing materials (especially organic) and reported values for their chi-2 and chi-3. Some effort has been given to adding to this tabulation values for non-linear optical properties reported since the completion of our report. Data published since May 1989 indicate especially large chi-3 properties for several phthalocyanine type molecular systems with interestingly large figures of merit (chi-3/absorbance). Other molecular systems with recently reported large values of chi-3 are (1) polydiacetylene, measured at 2.1 μm (Matsuda, Okada, Nakanishi & Kato, J. Photopolym. Sci. Technol. 2, 253 (1989)), and (2) the system



where D=electron donating group and X=halo group, reported

by Kurihara, Matsumoto, Kaino, Goto and Egawa, Jpn Kokai Tokkyo Koho JP 01 93,720 (89 93, 720) 1989. Hoechst Celanese Corp has applied for a European patent for acrylic polymers from the family of Monomers



where x is an electronegative group and R and R¹ are H, alkyl or alkylene groups. The resulting polymer is a clear, orange glassy material with a large chi-3.

The third quarterly report, September 1, 1989, also included an attached Working Draft Paper evaluating the feasibility of developing an ablative mirror-fuse system to be placed at the focal plane of an optical device. Incoming light would first pass through a focus at the reflective optical fuse before being recollimated prior to entering the observers eye. This draft paper proposed the use of a thermally unstable material (thermochemical enhancer), probably a polymer or an energetic material doped in a polymer in order to maintain optical flatness, under a thin (100-300 nm) reflective layer. This thin polymer layer would serve as a thermochemical enhancer for lowering the threshold for mirror-fuse activation. Further analysis of this concept is underway. Emphasis is being given to theoretically optimizing the reflective material as well as the thermochemical enhancer layer.

The Principal Investigator is also considering whether the linear photochromic response of a traditional photochromic material has any possibility for use in a

realistic eye/sensor protection system. Theoretical limitations on switching speed and degree of opacity provided when switched as well as ambient transparency are controlled by basic photophysical properties. The beginning of detailed analysis was presented in the appendix attached to the fourth quarterly report (18 Dec 1989) as a Working Draft Paper entitled "Limitations on Photochromic Techniques for Optical Protection of Eyes and Sensors." Further consideration of this approach and the associated theoretical analysis is continuing.

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