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Research Note

Gamma Rays Modification of Encapsulated Liquid Crystals Temperature Range

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Cholesteric Liquid Crystals have the interesting property of exhibiting reversible changes in their colors over a well defined temperature range.[1] They are used in many applications as sensitive temperature indicators.

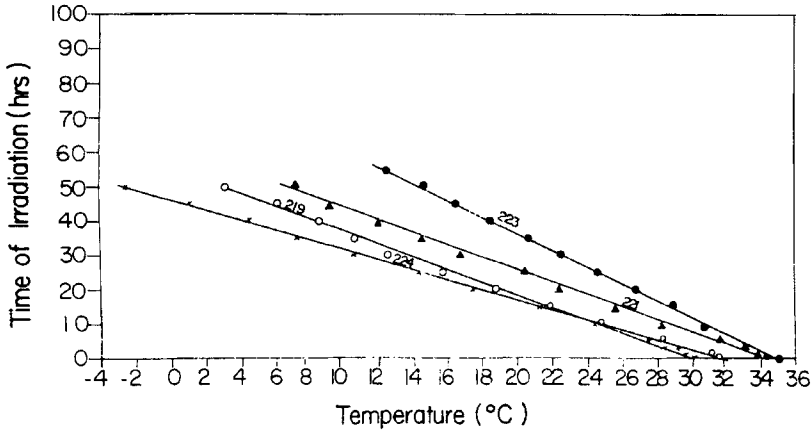
In recent years commercial sheets of encapsulated liquid crystals (ELC) have become available.‡ These sheets contain a carefully controlled layer of microdroplets of liquid crystals suspended in a thick resinous coating and protected from contaminants by a thin transparent polyester sheet on one side and by a black opaque coating on the other side. They do not contaminate easily, are stable over many months and they can be reused many times.

Various types of ELC sheets are available commercially from stock. They have fixed temperature ranges determined during the manufacturing processes. It is possible to order tailor made sheets according to customers' specifications. The economics of manufacture are such that it does not pay to handle very small orders.

In a study on the effect of γ rays on commercial ELC sheets[2,3] it was found that their whole temperature ranges are shifted to lower temperature after exposure to γ irradiation. This shift was found to be linear with dose and can be controlled to within ± 0.1°C. In one case it was possible to bring the range from 35°C to below 0°C. Once shifted by irradiation the temperature range remains stable for months.

† In partial fulfilment of the requirements for a Ph.D. degree.

‡ M. M. M. Company, Minneapolis (formerly Vari Light), NCR Company Dayton Ohio, and R. P. R. Inc. Dublin California.



As determined visually the brightness of the irradiated film remains the same up to about forty Mrads. At doses exceeding forty Mrads the colors are dulled and at very high doses it became hard to distinguish colors at all.

The effects of ^{60}Co γ rays (dose rate 0.98 Mrad/hr) on the temperature of the green-blue transition of samples of ELC sheets (part numbers 219, 221, 223, 224 purchase from Edmund Scientific Co) is shown in Figure 1. The results are summarized in Table I.

The possibility of altering the temperature ranges of ELC sheets with a high degree of control and precision should enable the individual user to obtain sheets with a required temperature range starting from sheets available from stock. A particular advantage of using gamma irradiation is the

TABLE I

The Temperature range of the colored ELC and the decrease of transition temperature per one Mrad of γ rays.

Type of ELC (part no.)	Temperature range of the unirradiated ELC (°C)	The decrease of transition temperature °C/Mrad		
		Black-Brown	Green-Blue	Violet-Blue
71141 (223)	33.9–36.8 (2.9)	0.42	0.41	0.39
71137 (219)	28.2–33.0 (4.8)	0.59	0.56	0.51
71139 (221)	32.3–38.0 (5.7)	0.59	0.57	0.53
71142 (224)	26.5–68.5 (42.0)	0.80	0.67	

precision which can be achieved by the use of a completely external source which can be removed at any desired stage of the process. Consequently this process may be of interest even to the manufacturer when sheets of very precise temperature range are required. This process is viable economically as the price of radiation treatment by commercial firms is of the order of $25–30 per Mrad for the irradiation of a cubic meter (Sorvan, Soreq Nuclear Centre Israel) which means, in terms of, the individual sheet something of the order of a few cents per irradiation.

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