LIQUID CRYSTALS
Applications and Uses

Vol. 1

Edited by
Birendra Bahadur
Display Systems Engineering
Litton Systems Canada Ltd.
Etobicoke, Ontario M9W 5A7
Canada

World Scientific
Singapore • New Jersey • London • Hong Kong

Published by

World Scientific Publishing Co. Pte. Ltd.
P O Box 128, Farrer Road, Singapore 9128
USA office: Suite 1B, 1060 Main Street, River Edge, NJ 07661
UK office: 73 Lynton Mead, Totteridge, London N20 8DH

Cover design: By Amir Novin, Kam Wan and Joy Tunnoch.
Microscope photograph of a polymer dispersed liquid crystal display in quiescent mode between crossed polarizers.

First published 1990
First reprint 1993

LIQUID CRYSTALS – APPLICATIONS AND USES (Vol. 1)

ISBN 981-02-0110-9

Printed in Singapore by Utopia Press.

List of Contribut

Numbers in parenthesis indicate the

16

Light Valve and Projection Mode LCDs

S.E. Shields
W.P. Bleha

Industrial Products Division
Hughes Aircraft Company
2051 Palomar Airport Road
Carlsbad, California 92009

Liquid crystal (LC) devices do not emit light of their own; rather, they modulate the intensity or polarization of light from an external source. This means that their application to projection devices is only natural. Researchers have taken advantage of this circumstance by devising a wide variety of LC devices for use in projection systems. Indeed, there is such a wealth of work which has been done that there is no doubt that an entire book could be written about projection uses of LCDs.

In this chapter we will concentrate on LC effects and devices which are currently being actively pursued. We intend to cover briefly not only the LC devices themselves, but also the other components (light sources, polarizers, etc.) required to make a complete projection LC system. Our treatment of necessity will be brief and superficial; thus we have had to be less complete in terms of describing all of the work which has been done over the years than we would have wished. Thus a number of devices have not been included, due primarily to space limitations.

Our discussion will begin with LC light valves (LCLVs). As summarized in table 16.1, we have divided them into two classes, based on how the input information is entered into the LCLV. Matrix-addressed LCLVs use a discrete structure integrated into the device to control the spatial location of the information; analog-addressed LCLVs have no inherent structure which localizes the information, but make use of the information wherever it happens to have been input. Typically analog LCLVs are addressed with an optical input from a CRT or a scanned laser beam, whereas matrix LCLVs are addressed electrically. After describing the LCLVs, we will continue with a discussion of projection systems, including other

components such as light sources and polarizers used in such systems. We will conclude with descriptions of a number of actual systems, most of which are presently commercially available.

Table 16.1. Classes of liquid crystal light valves

Analog-addressed	Matrix addressed
Photo-activated Laser addressed Electron-beam addressed	Multiplexed Active matrix

16.1 ANALOG-ADDRESSED LCLVs

A variety of devices have been fabricated which use an analog image input to control a LC layer. There are at least two methods which have been used to input the image into the LCLV - optical and electrical, using a beam of electrons. In addition, the optical method can use an image from a lens, from a cathode-ray tube (CRT), or from a scanned laser to access the LC layer by using a photosensor layer, or directly by heating the LC layer itself. All of these devices have in common that the LC layer is used to generate an image which can then be projected using white light onto a screen, or used for optical data processing (ODP) using a large-aperture laser beam.

16.1.1 Photoactivated LCLVs[a]

The photoactivated LCLV was invented and developed at the Hughes Aircraft Company Research Laboratories in Malibu, California in the 1970s. It is an optical-to-optical image transducer that is capable of accepting a low-intensity visible light image and converting it, in real time, into an output image using light from another source[1,2]. A photoactivated LCLV is shown in figure 16.1.

This type of LCLV consists of a photoconductor film and a nematic liquid crystal layer separated by a light-blocking layer and dielectric mirror (see figure 16.2). The photosensor film acts as an imaging, light-controlled voltage modulator for the

---

a. A good review of photosensor LCLVs is given in an article by W.P. Bleha (W.P. Bleha, *Laser Focus/Electro-optics*, October, 1983.)

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.