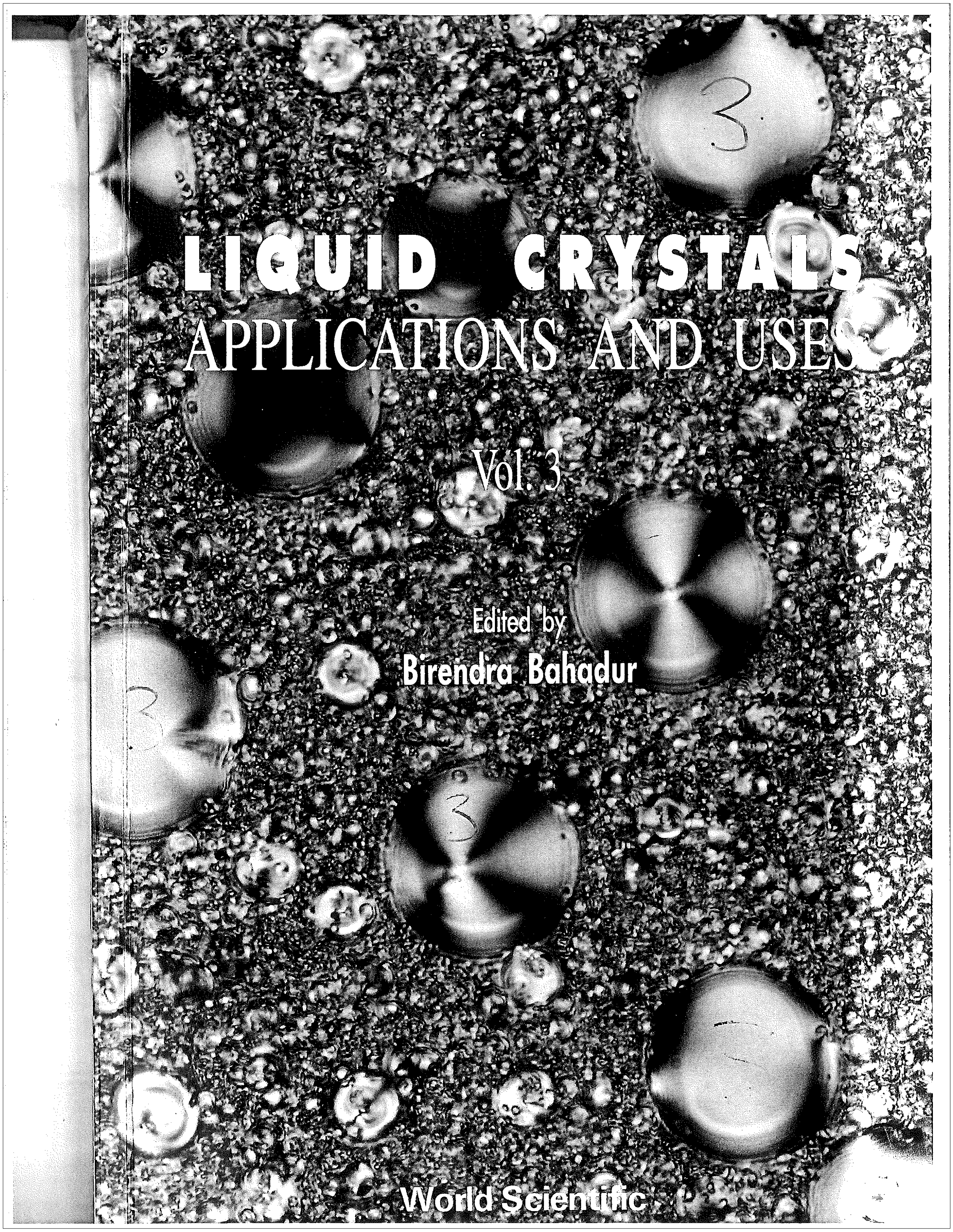
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Microscope photograph of a polymer dispersed liquid crystal display in quiescent mode between crossed polarizers.

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It is evident that these three characteristics will also be important in the use of LC's for optical computing. One may say, in fact, that they already are being used to advantage. As will be discussed below, active matrix twisted nematic LC television (LCTV) displays are pulled from their cases and peeled apart for use as electro-optic light valve arrays in optical connection prototypes[6], and LC's are already being used in an amazing variety of ways as electro-optic light valves to implement optical computing ideas[7]. Thus we predict that LC devices will have a major impact on optical computing and that commercial optical computing applications, optical inspection, for example, will employ LC spatial light modulators. In this review we highlight the first stirrings of what someday will be a rich and useful technology.

This chapter will focus on the conceived, prototyped, and potential uses of liquid crystals in Parallel Optical Processing (POP) and related technologies, and on the relevant operational characteristics of the LC devices used. The minimum will be said about the internal liquid crystal details of the electro-optic devices themselves as these topics are adequately covered in the other chapters of these Volumes and the citations therein. Rather, we focus on the role and operation of spatial light modulators, the basic parallel optical processing devices, and their implementation with liquid crystals. We provide a variety of examples of parallel optical processing devices and systems built around liquid crystal electro-optics.

17.2 LIQUID CRYSTAL SPATIAL LIGHT MODULATORS

In this section we review the LC devices useful in parallel optical processing applications and present some of the optical computing demonstrations and prototypes employing them, emphasizing the principal types: LC electrically addressed spatial light modulators including LC television-based devices, LC optically addressed spatial light modulators, and devices employing ferroelectric liquid crystals.

17.2.1 Spatial Light Modulators (SLMs)

An important theme in optical computing is the exploitation of the intrinsic parallelism of optics to do processing and it is in this area that liquid crystals are especially useful. A particularly elegant and ancient realization of this idea is optical Fourier transformation, wherein the optical electric field distribution in the Fraunhofer diffraction plane is the Fourier transform of an image field[8]. The ready availability of coherent light sources has made Fourier optics a powerful image filtering and processing technique[9]. The basic advantage of optics in this application derives from its intrinsic parallelism, the ability of light rays of differing wave vector to occupy the same space and to pass through each other, and from the analog nature of light. To take advantage of this parallelism in a processing application, the positional dependence in one or two dimensions of the electric field of an optical wave front must be manipulated in a way that can be easily and quickly changed, leading to the requirement for Spatial Light Modulators (SLMs), dynamically changeable devices which modify the amplitude, phase, and/or polarization of an optical wave front as a function of time and position across it. Although, as the example of Fourier optics shows, some fundamental ideas of