Establishment of Design Guidelines for Oriented Film Materials Used for Liquid Crystal Displays

Elucidation of factors determining the orienting power for liquid crystals

Research method

X-ray diffraction/scattering

Beamline used at SPring-8: Engineering Science Research I (BL19B2)

Achievements

- Finding that the orienting power of **oriented films*** determining the quality of liquid crystal displays is closely related to the **degree of crystallization**** of the oriented film surface
- Establishment of guidelines for designing materials used in oriented films with high orienting power for liquid crystals

R&D facility: Electronic Materials Research Laboratories, Nissan Chemical Industries, Ltd.

***Liquid crystal oriented film:** Liquid crystal displays can reproduce images by varying the alignment of liquid crystal molecules so that light is transmitted or blocked. An oriented film, a necessary component for aligning liquid crystal molecules unidirectionally, comprises a substrate coated with a grooved polymer film. Liquid crystal molecules are aligned in the groove direction when they come into contact with the oriented film. The quality of displays depends on the state of this alignment.

****Degree of crystallization:** Percentage of a crystalline substance consisting of both crystalline and amorphous phases.

Role of SPring-8

Background

The **quality of liquid crystal displays** depends on the orienting power of liquid crystal oriented films. There has been no established theory yet that can explain the factors associated with the orienting power, and the development of materials for oriented films was carried out with our experience acquired through trial-and-error research and inspiration.

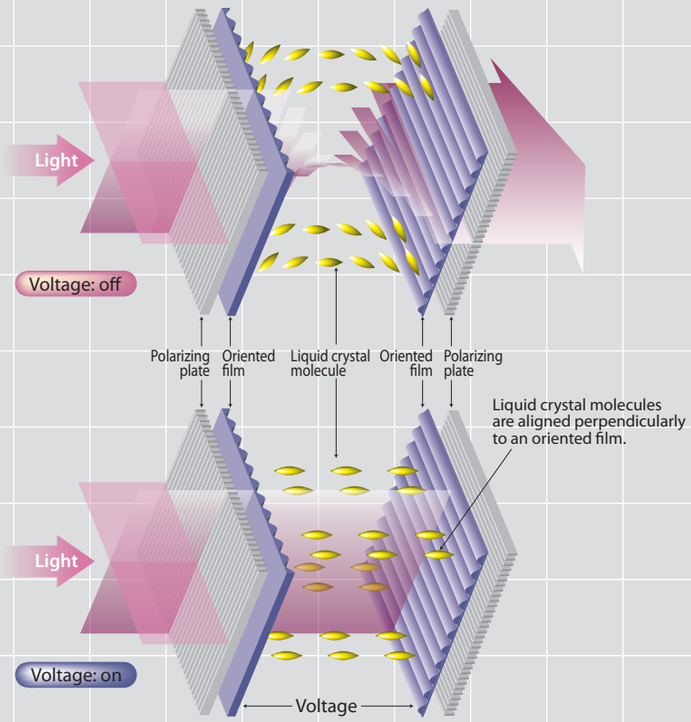
In the mid-course of the development, there has already been a suggestion - the degree of crystallization of liquid crystal oriented films is related to their orienting power. Unfortunately, it was impossible to obtain details of this finding by carrying out measurements in general laboratories.

Results

First, the degree of crystallization of liquid crystal oriented films was measured using the high-brilliance X-ray of SPring-8 and its high-precision measurement system. The result indicated that the degree of crystallization was different between the oriented film surface in contact with liquid crystal molecules and deep in the film.

In addition, oriented films with different orienting powers were examined by grazing incidence X-ray diffraction. We clarified that the higher the degree of crystallization at the oriented film surface in contact with liquid crystal molecules, the better the orienting power. The orienting power was not affected by the degree of crystallization deep in the film.

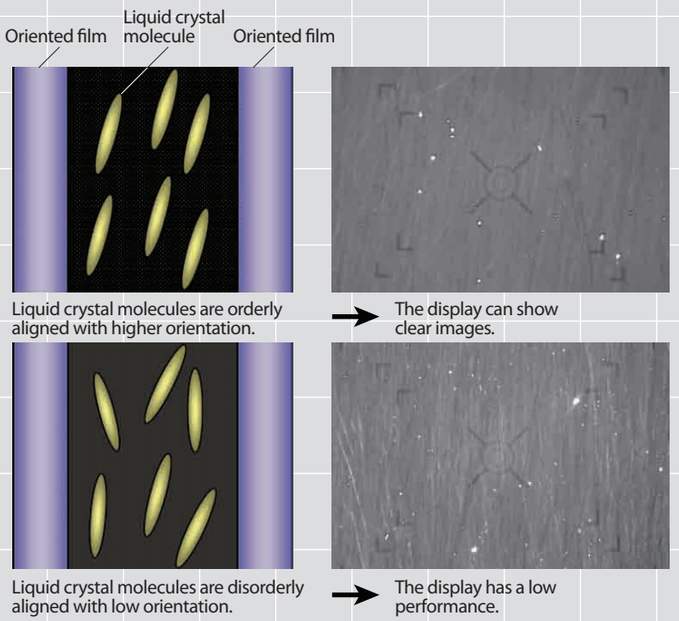
We can now design the materials for oriented films using the above results as guidelines.



Principle of liquid crystal display

Two oriented films sandwich liquid crystal molecules and are placed so that the directions of their grooves are 90° different from each other. Accordingly, the lines of liquid crystal molecules are twisted by 90°, thus traveling light is twisted through them. The light is guided to one of the polarizing plates (which transmit light in only one direction) that are placed outside the oriented film. When a voltage is applied between the two oriented films, each liquid crystal molecule becomes perpendicular to the films; hence, the light travels straight and cannot pass through the second polarizing plate, the polarizing direction of which is at an angle of 90° to that of the first polarizing plate. The light is thus controlled by turning the voltage on or off.

Quality of display



Measurement results for liquid crystal oriented film (surface)

The peak of scattering intensity becomes high with a higher degree of crystallization (higher orienting power) at the oriented film surface.