

What is Liquid Crystal Fluid

Liquid crystals are long chain organic molecules that exhibit the properties of a liquid yet have the long range ordering of a solid. The liquid crystalline state constitutes an intermediate phase or mesophase between solids and liquids. There are several types of liquid crystals and the ones used for displays are called thermotropic liquid crystals. As the name implies, thermotropic liquid crystals are affected by heat. If heat is added to the crystalline phase of the liquid crystal it will transition into the smectic phase (melting point), as more heat is added the liquid crystal will go through the nematic phase (used for display applications) and finally into the isotropic phase (clearing point) see fig 1.

Twisted nematic (TN), supertwisted nematic (STN) and active matrix (AMLCD) displays use the nematic phase for their operation. This phase is selected for its physical properties and the widest temperature range. It should be noted that the fluids used for display purposes are mixtures of several different liquid crystals. By mixing several liquid crystals together, a eutectic mixture will result with the melting point depressed well below room temperature. Liquid crystals are uniaxial. For example, if one measures the physical parameters of a water molecule, it can be shown that the data for that parameter would be the same no matter what direction the measurements were taken. Liquid crystals differ in that the value of the physical parameter is dependent on the direction it was measured relative to the molecule. We can measure the index of refraction of the molecule perpendicular to the long axis, and then parallel to the long axis, and the two values would be different, see fig 2. This is the index of refraction anisotropy of the liquid crystal or the birefringence. This would also hold true for the magnetic susceptibility, electrical conductivity, thermal conductivity, dielectric permittivity, and elastic constant.

Because liquid crystal molecules want to lie parallel to one another (orientational order) and they are uniaxial (anisotropic), we can exploit these properties to make useful devices.