Cosmetic Applications of Cholesteric Liquid Crystals

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We are all aware of the three common states of matter: solids, liquids, and gasses. There is, however, a less-commonly known state of matter that is "in between" solids and liquids: liquid crystals. Liquid crystals have numerous familiar applications in LCD displays for calculators, watches, computers, and televisions, and are used as color-changing sensors for thermometers, battery charge indicators and "mood rings". Liquid crystals can be classified into two types: lyotropic and thermotropic. Lyotropic liquid crystals are generated when molecules become structured when dissolved in a solvent; many surfactants can form lyotropic phases when dissolved in water. Thermotropic liquid crystals are formed in a particular temperature range intermediate to the solid and liquid ranges. A certain type of thermotropic liquid crystals may be used in cosmetic and personal care products to give a striking iridescent visual effect. This article will review the basic chemistry and physics of thermotropic liquid crystals and the applications of these materials for cosmetics and personal care.

Basic Chemistry of THERMOTROPIC Liquid Crystals

In 1888 Friedrich Reinitzer, an Austrian botanist, noticed that cholesteryl benzoate displayed some unusual optical properties when melted from the solid. He had discovered a new state of matter, later named liquid crystals, which had some properties characteristic of crystalline solids and some characteristics of liquids.

In **crystalline solids**, the molecules exhibit both positional and orientational order; i.e. they are not free to move and are aligned in a certain direction. In normal **liquids**, the molecules have neither positional nor orientational order; they are oriented randomly and their motion is not constrained (Fig. 1). They are termed isotropic because they have the same properties in all directions.

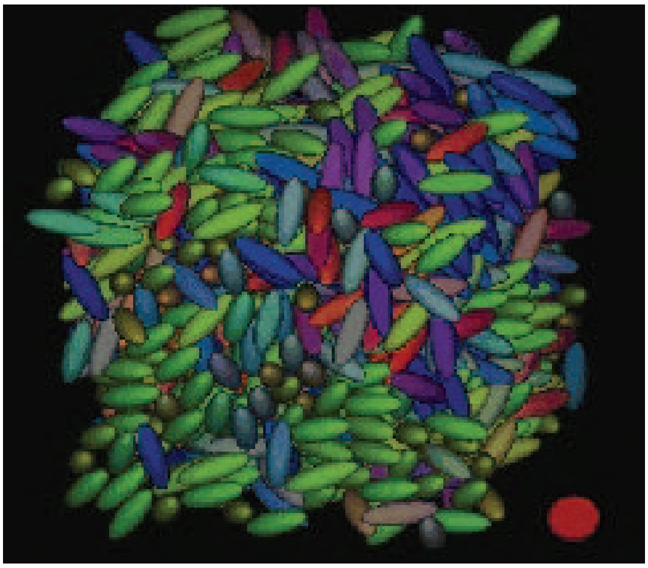

Fig. 1 Isotropic Liquid

Certain organic compounds can form a **liquid crystal** phase intermediate to solids and liquids. When solids of these materials are heated, they do not melt into a clear isotropic liquid. Instead, they melt to form a phase that exhibits orientational order (they point in the same direction) and may also have some positional order. Thus, the molecules are more ordered than isotropic liquids but less ordered than crystalline solids. Upon further heating, there is a second phase transition to a true liquid. Compounds that form liquid crystal phases usually have rigid molecules with a rod-like structure and a strong dipole.

There are many different thermotropic liquid crystal states depending on the degree of order of the material. In the Nematic liquid crystal phase the molecules are aligned pointing generally in the same direction, but are not otherwise ordered (Fig. 2). The axis in which the molecules are aligned is called the director, which is the bottom left to upper right axis in the Figure 2. Nematic liquid crystals exhibit orientational order but no positional order.

Cosmetic Science Technology 2004