With this article we continue the series describing the physical properties and the experimental determination of liquid crystals and liquid crystal mixtures. The following contribution focusses on the determination of the various temperature transitions, the nature of which was introduced in an earlier article devoted to "Optical phase identification".

PHYSICAL PROPERTIES OF LIQUID CRYSTALS: II. DETERMINATION OF TRANSITION TEMPERATURES

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I. INTRODUCTION

The transition temperatures for liquid crystalline single compounds and mixtures are important quantities characterizing the material. The difference in transition temperature between the melting and clearing point is the *mesophase* range of the substance. For substances with more than a single liquid crystalline phase the *higher* ordered phase exhibits the lower transition temperature. For example, the liquid crystalline phases may appear in the following sequence:

SmH SmG SmF SmI SmB SmC SmA N

or

SmE SmB SmC SmA N

Of course, not all phases need to be present for a specific material. Within a homologous series there are pronounced variations for the respective phase transitions (e.g. for the clearing point): with increasing alkyl chain length the clearing point decreases. An even-odd effect is observed in the sense that clearing points for compounds with even chain length have a higher value.

Also, a semi-quantitative statement on the purity of a substance can be made by the temperature range over which the clearing takes place. Compounds of high purity have narrow clearing ranges of typically 0.3 to 0.5 K; with increasing amounts of impurities this range will steadily increase to over 1 K.

Transition temperatures may be determined for both single substances and mixtures. For the determination of the transition temperature of liquid crystals three main instruments are available:

1. Mettler oven
2. Microscope hot stage
3. Differential scanning calorimeter (DSC)

The first two approaches will be discussed below while an extensive treatment of the use of a DSC in context with liquid crystals is deferrred to a later contribution in this series.

II. THE METTLER OVEN

1. Technique

The Mettler oven can detect small changes in transmission as a function of temperature. For liquid crystals one may expect a change of optical properties for every phase transition. Under these experimental conditions, the transmission of a liquid crystal increases with decreasing order parameter. This results, for solid and smectic states, in a low transparency, while the nematic and isotropic states have a higher one.

In order to perform a measurement, a melting tube is filled with the respective substance and placed into the oven. A heating rate of 2 K/min proved to be sufficient for the desired accuracy and reproducability of 0.1 K. The starting temperature of the scan should be at least 10 K below the expected transition. Any change in transmittance is monitored by a built-in photo-diode in the oven, resulting in a photocurrent which is proportional to the transparency of the sample. It is the