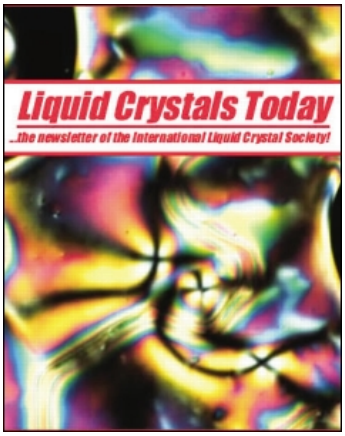

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The Categorization of Blue Phases

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The Categorization of Blue Phases

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Structural studies of blue phases (BP) which exist just below the clearing point in low-pitch cholesterogenic systems have attracted the attention of numerous groups during the past two decades. The optical isotropy of BPs is nowadays well understood in terms of a cubic lattice structure of defects, and evidence for this is derived from experimental results [1, 2] as well as from theoretical studies [3].

In the absence of a field the situation for blue phases and consequently their nomenclature is rather straightforward. There are three thermodynamically stable types of blue phases, in the order of increasing temperature designated as BPI, BPII, and BPIII. Evidence for this polymorphism and the phase stability has been obtained some time ago from differential scanning calorimetry, optical microscopy [4], optical rotatory dispersion measurements (especially for BPIII [5]), and adiabatic calorimetry [6].

A more complicated situation arises in the categorization and description of those blue phases which are induced by the influence of electric fields and are only stable in presence of an electric field. The first example of such an electric field-induced BP was described by Pieranski *et al.* in 1985 [7], but as early as 1976 such a phase was predicted theoretically by Brazowski *et al.* [8] and later more precisely by Hornreich and Shtrikman [9]. Soon after, several other field-induced BPs were detected [10, 11] the structure of which deviated from cubic symmetry, and they were investigated by means of Kossel diagrams [12]. Transitions between different field-induced BPs have also been studied leading to temperature/field strength phase diagrams [13]; for details we refer to Chapter 4 of Kitzerow's review article [14].

Generally, in the literature there is an unsatisfactory situation concerning the nomenclature for these electric field-induced blue phases. The first field-induced blue phase has been denoted BPX [7]. In 1987 we introduced the designation **BPE** for field-induced blue phases [11] where the letter **E** stands for ***electric*** field. This designation has also been used by other authors, e.g. [15]. For sub-types of BPEs small roman type letters have been added (not necessarily as subscripts), e.g. BPEa, BPEb, BPEc, ... [13]. This proposed nomenclature does not provide any information about the lattice symmetry of the BPEs (which is also absent in the nomenclature of zero-field BPs). Indeed, from Kossel diagrams and morphological studies we know that there are BPEs with tetragonal and two- and three-dimensional hexagonal structures (cf. [14]). For the latter ones the nomenclature BPH^{2D} and BPH^{3D} has been proposed [10]. However, these symbols are lacking in information about their stability in electric fields. Consequently, the letter E also has been attached to the symbol of a supercooled, metastable BPS which is transformed into a metastable BPES by the influence of an electric field [16].

It is proposed that the capital letter **E** be added to all field-induced BPs, and different types can be distinguished by small letters, but not necessarily as subscripts. In the following table field-induced blue phases as given in the literature are listed up showing possible identities between types of different nomenclature (cf. also table III in [14]).

Recently, blue phases have been described which are built up by discotic molecules [19, 20] whereas all blue phases reported before belong to calamitic molecules.

Table. Field-induced blue phases.

BPEa [13] ↔	BPX [7]	tetragonal I	4_122	[17]
BPEb [13]			(uniaxial)	
BPEc [13] ↔	BPH2D [10]	hexagonal	(uniaxial)	
	BPH3D [7]	hexagonal	e. g. $P\,6_222$	[7]
BPEd [18]				
BPES [16]				

These phases have been named *discotic blue phases* with symbols $\mathbf{BP_DI}$, $\mathbf{BP_DII}$, and $\mathbf{BP_DIII}$ where the subscript D stands for discotic. However we suggest that this designation should not be used since the nomenclature is not concerned with the molecular structure of the mesogens.

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