Dimensionality and Alignment of Organic Semiconductors

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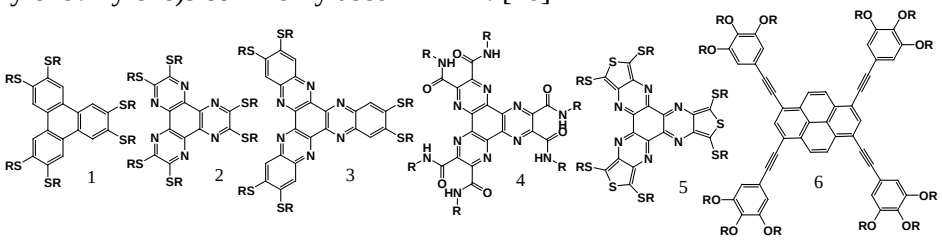
The discovery that 2,3,6,7,10,11-hexahexylthiotriphenylene **1** exhibits a charge carrier mobility (μ) on the order of μ = 0.1 $cm^2V^{-1}s^{-1}$[1], has created wide scientific and technological interests in discotic liquid crystal as potential candidates for optoelectronic applications [2]. Since then, μ of several mesogenes based on hexabenzocoronene, triphenylene, and phthalocyanine aromatic cores have been studied [3]. Values of μ as high as 0.5 $cm^2V^{-1}s^{-1}$ have been reported for the columnar mesophase of hexabenzocoronene derivatives [4]. Such mobility approaches the corresponding value for the intersheet μ in graphite (3 $cm^2V^{-1}s^{-1}$) and matches those of single crystals of aromatic compounds [4]. However, most of the discotic mesogenes reported so far have in common to be better hole carriers than electron carriers [3]. Only a few examples of electron carrier discotic mesogenes exist to date [5,6] creating, therefore, the need for new materials.

We will report the synthesis, mesophase characterisation and property investigation of new type of discotic molecules such as **2,3**. The presence of six nitrogen atoms in the aromatic core is anticipated to significantly increase the first reduction potential facilitating electron injection and high electron mobility [7]. Surprisingly, it was discovered that the six nitrogen atoms caused a dramatic change in the mesomorphic behaviour [8]. Whatever its side chains, compound **2** is not liquid crystalline whereas structurally related **1** and **3** exhibit one to several liquid crystalline phases. The occurrence of liquid crystalline mesophases appears for mesogen **4** when thioalkyl side chains are replaced by side chains connected by amide functions. An extremely short intracolumnar distance of 3.18 Å is observed for this compound that exhibit an unusually high charge carrier mobility [9]. This short distance is imposed by intermolecular Hydrogen bonding. Compound **4** can be viewed as a supramolecular polymer where repeating units are connected by non-covalent bonds. We will also report on highly fluorescent columnar mesophases and crystals. The concept of non-parallel transition dipoles has then be successfully extended to mesogen **6** that forms columnar hexagonal mesophases. A fluorescence quantum yield as high as ϕ = 0.6, i.e. superior to the values encountered for poly(fluorene)s and poly(p-phenylenevinylene)s commonly used in LED! [10]



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