Oriented Growth of Dialkylterthiophenes on Nanorubbed PTFE Substrates Determined by Bragg Rod Analysis

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One of the more recent ways of research development in nanotechnology area concerns the organic electronics. Within this field, the different research works aim at best understand the narrow relations linking the molecular structure, charge transport, excited state’s migration, matter organisation at the interfaces and nanofabrication processes.

Typical compounds for organic semiconductors at low-cost device manufacture are conjugated polymers but also liquid crystals. However, due to anisotropic properties, high degree of molecular ordering is a very crucial issue. Hence, processing conditions play a critical role in the final device performance, so establish the optimal structural organization in thin films has been a required challenge for an efficient charge transport. Among the various orientation methods recently conceived to align organic chains in thin films, there is one which provides an efficient orientation with precise control of the spatial localization of the oriented regions with a nanometric resolution, feature that cannot be easily achieved with the “classical” techniques. This method combines in an original way two concepts: template growth and nanorubbing. Indeed, it is now recognized that a crystallization process can be used to align the chains in semicrystalline rigid polymers. Besides, upon rubbing amorphous polymer surfaces, the formation of crystalline aggregates can be observed on the surface, which are perfectly aligned along the sliding direction [1]. These aggregates then act as a template to propagate the chain orientation to the whole film when the polymer is heated to the crystallization temperature. This kind of template growth is clearly reminiscent of epitaxial growth.

Lately, we have expanded this concept of device manufacturing to some specific calamitic liquid crystals recently synthesized by us, i.e. a series of symmetrical $\alpha,\alpha'$-dialkyloligothiophene homologues [2]. Here in this work, we focus on thin film samples prepared with a series of dialkylterthiophenes, varying the alkyl chain length from 6 to 9 carbon units on each side of the aromatic core.

The films prepared were then grown and aligned after spreading onto a nanorubbed PTFE coating silicon substrate. In order to check the quality of the film alignment and then to ensure the system probed is not possibly diphasic (with for instance some fraction of the molecules lying down in the surface plane), we investigated the films above at room temperature by grazing incidence X-ray diffraction (GIXD) experiments, in and then out-of-plane. In-plane diffraction experiments were first used to exhibit the lattice organization and then compare with the structure of their bulk material homologues [3], while out-of-plane diffraction (Bragg rod measurements) were helpful to estimate the average tilt and azimuthal angles of the alkyl chains. This will enable us to conclude about the applied efficiency to align by nanorubbing small liquid crystal molecules such as dialkylterthiophenes.
References


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