Color switchable hybrid LEDs based on aligned conjugated polymer multilayers

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Research on conjugated polymer thin films and devices has demonstrated that peculiar optical and electrical properties can be obtained using processes that induce unidirectional polymer chain alignment.[1] In fact, previous studies have demonstrated that by aligning polymer chains using techniques such as electrospinning, rubbing or unidirectional epitaxial growth, one can fabricate thin films with polarized absorption or emission properties. While all the previous studies focused on only one of these chain alignment processes, using poly(9,9-dioctylfluorene-co-benzothiadiazole) (F8BT) as a reference polymer, we compared the various fabrication methods in terms of photoluminescence polarization ratios (P_R).

Our results clearly indicate that the combination of two alignment strategies, namely, epitaxial growth using 1,3,5-trichlorobenzene (TCB) and off-center spin-coating, show the best results with P_R values up to 2.5 (Figure 1). These results are not limited to F8BT (green-emitting) and can also be applied to other conjugated polymer systems such as poly[2-methoxy-5-(2-ethylhexyloxy)-1,4-phenylenevinylene] (MEH-PPV) which emits in the red region of the visible spectrum.

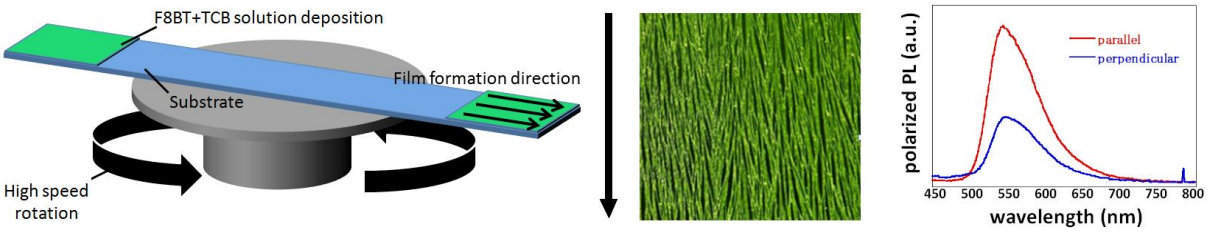
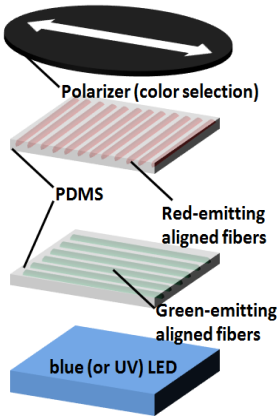


Figure 1: Schematic representation of alignment process, resulting unidirectional fibers and polarized PL



Furthermore, we designed an innovative hybrid device in which two perpendicularly polarized polymer layers are deposited on top of an inorganic LED thus combining the long-lasting emission properties of inorganic materials with easily polarized organic films. To avoid rapid photo-oxidation of the organic layers and improve their handling, we have incorporated the aligned polymer chains into a silicon elastomer material (PDMS) with oxygen and moister barrier properties (Figure 2). As the emission color of these hybrid devices can be easily tuned by rotating a polarizer, our concept could easily be applied lighting and display technologies in the future.

Figure 2: Schematic representation of the hybrid bipolarized light-emitting device

[1] V. Vohra, T. Anzai. Molecular Orientation of Conjugated Polymer Chains in Nanostructures and Thin Films: Review of Processes and Application to Optoelectronics. *Journal of Nanomaterials 2017*, 3624750 (2017)