Melt-processing of highly crystalline organic semiconducting layers for organic optoelectronics

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Organic semiconductors have been intensively investigated and used in a variety of organic optoelectronic devices such as organic light-emitting diodes (OLEDs), organic lasers, organic solar cells and organic field-effect transistors. A number of different techniques including vacuum vapor deposition and spin-coating have been used to deposit them into thin films. Here, we report on an improved solvent-free and vacuum-free melt-processing method to prepare organic semiconducting films with large crystal size.[1] For this purpose, we used a solution-processable oligo(*p*-phenylene vinylene) derivative substituted at both extremities with pyrene moieties. Compared to previous protocols already reported in the literature, our work provides evidence that an accurate control of the temperature during the recrystallization of this material from the melt allows the formation of large single crystal monodomains in the films. As a consequence of the presence of these large-size crystalline monodomains, the melt-processed organic films exhibit in transistor configuration higher charge carrier mobilities than in spin-coated polycrystalline thin films. We then investigated the photophysical and amplified spontaneous emission properties of the spin-coated and melt-processed thin films. The photoluminescence quantum yield was found to increase with the extent of crystallinity of the organic layer, due to a reduction of the number of grain boundaries. In addition, amplified spontaneous emission could be observed only in the melt-processed film. Overall, this work shows a simple and versatile melt-processing method to fabricate organic layers with large crystal size, suitable for the realization of organic electronic and light-emitting devices.

[1] J. C. Ribierre et al., J. Mater. Chem. C 2018, DOI: 10.1039/C8TC04834G