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Temperature Dependence of Bis(triisopropylsilylethynyl)-Pentacene Nanofilm Deposited on OTS-SAM Surface as A Transistor Channel

Cheongjong Yu[1], Tae-KwanKim[2], Sangil Choi[3], Youngmin Bae[3], and SungsooKim[3]*

[1]Pohang Accelerator Laboratory, Pohang University of Science and Technology, Pohang, Kyungbuk, 790-784, Korea

[2]Institute of Basic Science, Sungkyunkwan University, Suwon, 440-746, Korea

[3]Department of Nano-Polymer Materials Engineering, Pai Chai University, Daejeon, 302-735, Korea

Highly pure 6,13-bis(triisopropylsilylethynyl)pentacene (TIPS-PEN) nanofilms were deposited on a hydrophobic OTS-SAM surface at two different substrate temperatures (70°C and 90°C) via the vacuum thermal evaporation (VTE) method. X-ray reflectivity measurements over a wide temperature range (30°C-284°C) revealed that out-of-plane crystallinity of the film (~10 nm) remains intact but in-plane crystallinity starts to become poor from ~100°C, and to become much more worse from 260°C. Atomic force microscope images showed that TIPS-PEN films (~55 nm) prepared at the substrate temperature of 90°C or above commonly have a number of huge cracks between enormous crystal domains (up to 3mm) whereas the films didn't form such morphology below T_s=90°C. These results clearly suggest that an optimum substrate temperature of TIPS-PEN nanofilms on OTS-SAM surface must be somewhere between 70°C and 90°C, and the process temperature must be kept below 90°C in order to form and maintain a highly crystalline film for an organic thin film transistor device since in-plane crystallinity of a semiconductor channel deeply affects the performance of a transistor.