

Spontaneous aggregation of pentacene molecules on SiO₂ substrate

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Pentacene (C₁₄H₂₂) is one of the most promising organic semiconductors for organic field effect transistors (OFETs). In spite of past extensive studies aiming at the improvement of their performance (mobility), there remain crucial problems, namely, reproducibility and reliability. In the present study, we found drastic spontaneous aggregation of pentacene ultrathin films on SiO₂ even under high vacuum and ambient temperature conditions. This should be one of the major origins of the instability and irreproducibility of pentacene-based devices. In fact, we found that the characteristics of pentacene FETs were severely affected by this spontaneous aggregation even in the FET with the thicker (~10 nm) pentacene layer.

As shown in the Figure, the spontaneous aggregation of pentacene films was observed with both atomic force microscope (AFM) and low-energy electron microscope (LEEM) even under different conditions (AFM: 1.25 ML thick film on thermal oxide SiO₂ substrate in 1×10^{-4} Pa; LEEM: 2.25 ML thick film on native oxide SiO₂ substrate in 5×10^{-8} Pa). We have confirmed that these aggregations were not caused by scanning by cantilever or electron flux. μ -LEED observation revealed that the crystallinity of pentacene film was improved and the in-plane lattice constant was increased in the aggregated domains. The origin and the mechanism of the aggregation will be discussed.

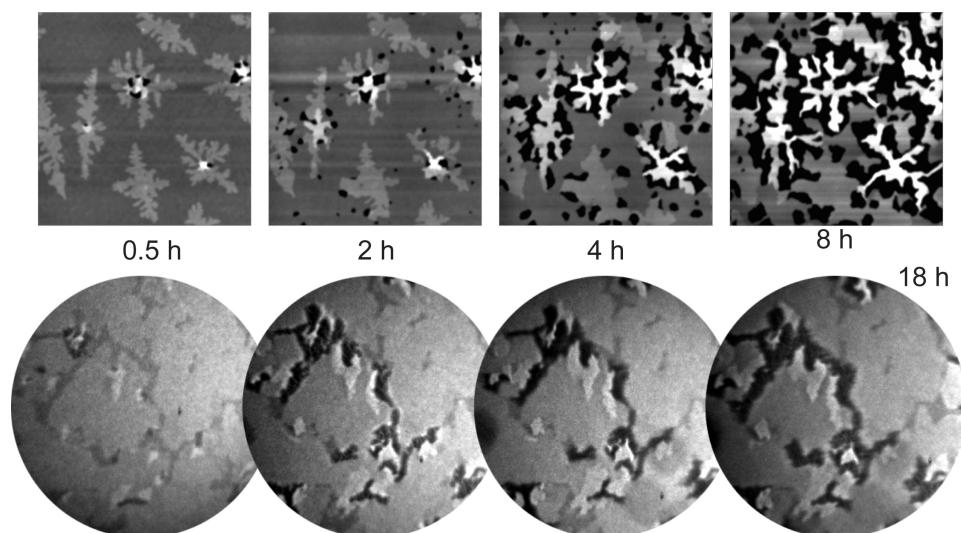


Figure: Morphological change of the pentacene thin film after deposition on the SiO₂ substrates observed by AFM (upper sequence) and LEEM (lower sequence). The numbers in the figures showed the elapsed time after the deposition of pentacene. Image size is 5 micron $\times$ 5 micron (AFM) and 10 micron (LEEM).