Production of Organic Thin Films Using Rapid Expansion of Supercritical Solutions (RESS) Technique

Hirohisa UCHIDA [1], Tatsuya FUJII [1], Dai YAMAMOTO [1], Masakazu SUGIYAMA [2]

[1] Department of Chemistry and Material Engineering, Faculty of Engineering, Shinshu University, Japan
[2] Institute of Engineering Innovation, School of Engineering, The University of Tokyo, Japan

Organic semiconductors offer a promising technology for low-cost, large-area and wearable electronics on flexible substrates. Device performance is greatly dependent on structure, morphology and properties of thin films. In order to improve device to meet future demands, new approaches are needed to produce high-quality thin films composed of larger grain sizes and smooth grains with suitable thickness to give better carrier mobilities.

Supercritical CO_2 is new-type attractive solvents and has been applied in material processing because their solvent power is moderate, and their transport properties are favorable in mass transfer rates. Rapid expansion of supercritical solutions (RESS) technique has been paid much attention and has been expected as an effective and environmentally friendly organic material design method. In this work, the study on the production of organic thin films for organic semiconductors via RESS technique using supercritical CO_2 has been performed.

The RESS apparatus is basically a flow-type and consists of a section of preparing a supercritical solution saturated with a solute, and that of production of thin films. The supercritical CO_2 saturated with the solute was expanded rapidly through a capillary nozzle to a silicon substrate on a heated plate. Two-dimensional nucleation occurred on the substrate, followed by the production of thin films by the growth of deposited islands (grains).

We successfully produced thin films or large grains for anthracene, pentacene, perfluoropentacene and ruburen. Controlling the flow rate from the nozzle and the distance between the nozzle and the substrate prevented homogeneous nucleation above the substrate in spite of a large supersaturation between a section of preparing a supercritical solution saturated with a solute and that of production of thin films. Moreover, the structural properties of the thin films were found to be strongly influenced by the supersaturation and the distance between the nozzle and the substrate.