論文の内容の要旨

論文題目　Study on Solution Process for High Performance Organic Thin-Film Transistors
（塗布工程による高性能有機薄膜トランジスタに関する研究）

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Organic thin-film transistors (TFTs) have been quite attractive because of their mobilities comparable to amorphous silicon and potential for solution processing that enables large area and low cost electronics. In the last decade, the performance of solution-processed p-channel organic TFTs has been dramatically improved. However, the performance of n-channel organic TFTs is not comparable to that of p-channel TFTs. To realize high performance complementary metal-oxide-semiconductor circuits, development of a novel solution process is strongly required.

In this thesis, I would like to introduce several solution process techniques for high performance n-channel organic TFTs using C_{60} fullerene as a channel material. C_{60} is a very promising n-type semiconductor from its high electron mobility. However, because of low solubility and high recrystallization nature of C_{60}, a fabrication of uniform C_{60} thin-film has not been reported.

In chapter 3, characterization of a polymer blended C_{60} thin-film will be described. The polymer blending technique effectively prevents the crystallization of the C_{60}. Although uniform thin-film was formed by spin-coating, large amount of the polymer ratio disturbed charge transportation.

In chapter 4, solvated C_{60} crystal structure and its transistor characteristics will be described. For alignment of C_{60} single crystal with source and drain electrode, a selective area crystal growth technique was performed. In this chapter, understand for role of solvent residue in C_{60} crystal structure is described. Although we confirmed high potential of C_{60} as an electron channel material thanks to experimental results from chapter 3 to chapter 4 offered, meaningful transistor performance that can be applied practical device did not obtained.

Basically uniform and pure C_{60} thin-film fabrication is necessary to obtain high performance TFTs. We developed a novel solution drying process that provides a high quality thin-film. In chapter 5, we discuss a discovery of vacuum drying process and its mechanism. We fabricated TFTs using vacuum-dried C_{60} thin-film as a channel and obtained comparable electron mobility with vacuum-evaporated C_{60} TFTs. The selection of solvent is discussed in chapter 6. Not only a thin-film morphology but also transistor performance of vacuum drying process highly depends on the solvent.

In chapter 7, we describe inkjet-printed high performance C_{60} TFTs. We applied vacuum drying process, which was described in chapter 5, to inkjet printing technique. By applying inkjet printing technique for pattering C_{60} solution, we could form the C_{60} thin-film on a polymer gate dielectric layer, which is solution-processable on flexible substrate.

In this chapter, origin of the high performance transistor characteristics and its variance will be discussed.

Finally, in chapter 8, we will summarize solution processes that have been discussed previous chapter and describe prospect of the solution-processed C_{60} TFTs.