Characteristic Improvements for Bottom Contact OTFTs with Self-Assembled Monolayer Formed by ALD

H. Kim, J. Park, K. W. Bong, J. M. Kang, H. M. Kim and J. S. Choi
Department of Electrical, Information & Control Engineering, Hongik University Seoul, Korea.

Abstract

The interaction of π-conjugated pentacene layer with metal contact or gate dielectric surfaces strongly affects the growth process and determines the morphology of the organic film. In particular, in bottom contact configuration the polycrystalline pentacene film degrades in an amorphous phase along the boundaries of the source and drain contacts, decreasing the performance of the devices. It has been demonstrated that the interaction of the π system with the interfaces can be decreased by covering the surface with a monolayer of octyltrichlorosilane, before the deposition of pentacene. One of critical factors for high performance of OTFTs is the properties of the interface between semiconductor and gate insulator, because the growth of pentacene molecules is strongly affected by the deposition conditions and the surface properties of gate insulators or substrates. It is known that the vertical alignment of pentacene molecules provides a strong π-π* overlap and can increase the electrical conductivity in the direction perpendicular to the long axis of pentacene molecules. The hydrophilic surface polarity of PVP layer prior to the deposition of pentacene can deteriorate the upright growth of pentacene molecules to the substrate. In this work, octyltrichlorosilane was deposited onto PVP layer prior to the deposition of pentacene to modify the surface polarity of PVP by ALD method. The surface polarity of the gate insulator became more hydrophobic by the SAM on the PVP layer. The change of the surface polarity induces the molecular ordering of the pentacene film deposited on the SAM, which enhances the charge channel formation and transport of the carriers. The electrical characteristics of the fabricated OTFTs are shown in Fig. 1. For the device with the SAM layer, μ_{FE}=1.17*10^{-2} cm^2/*V s*, V_{th}=-2 V, and on/off current ratio of ~10^3 were extracted, while the device without the SAM layer presented μ_{FE}=2.7*10^{-3} cm^2/*V s*, V_{th}=-8 V, and on/off current ratio of ~10^2.

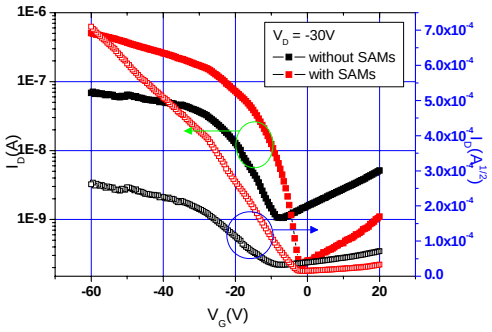

Figure1. Transfer curve in the saturated regime at a constant source-drain voltage of -30V