High-Rise 3D Organic Integrated Circuits with Via-Hole-Less, Multi-Level Metal Interconnect using iCVD

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Three dimensional stacking of organic thin-film transistor (OTFT) is one of the solutions to increase the integration density of organic integrated circuits (ICs). In particular, three-dimensional ICs requires an increased number of vertical interconnects between layers, and therefore multi-level metal interconnect is an essential technology for the large-scale 3D-OTFT ICs. Here, we present a multi-level metal interconnect scheme using solvent-free patterning of insulator layers to form interconnecting area for the reliable electrical connection of two metals in different layers. Using the highly reliable interconnect method, a high-rise 3D organic IC consisting of 5 OTFTs and 20 level of metal layers was successfully fabricated in solvent-free manner, which is the highest stacked OTFTs to date. All transistors exhibited outstanding device characteristics including high on/off current ratio, no hysteresis behavior. We also demonstrate double 3D-stacked complementary inverter circuits that use transistors on 4 different floors with a 100% output voltage swing.