Transparent Conductors and Printable Electronics Focus Topic
Room: East Exhibit Hall - Session TC-ThP

Transparent Conductors and Printable Electronics Poster Session

TC-ThP1 A Combinatorial Thin Film Sputtering Approach of the Synthesis and Characterization of Al_2O_3-TiO_2 High-k Dielectrics for Oxide TFT Application, ***J.H. Noh****, J. Noh, P.D. Rack,* The University of Tennessee

For the last decade, oxide based thin-film transistors (TFTs) have been extensively investigated because of their transparency, high mobility, low process temperature which are expected to serve as the basis for new optoelectronic and flexible devices. However, most of the work on oxide TFTs still rely on conventional dielectrics from Si technology, such as plasma-enhanced chemical vapor deposited (PECVD) SiO_2 or SiN_x with process temperature of 250–300°C. For high performance, low-cost and flexible electronics, high-k dielectrics at low process temperatures are needed. rf sputtering is alternative process for low temperature dielectrics. Usually, the deposition rate with oxide target is very low, so it is not compatible for mass production. In order to overcome this problem, reactive sputtering is adapted in this study. Although oxide TFTs with low-temperature sputtered materials such as Al_2O3, HfO_2, Y_2O_3, Ta_2O_5 have already been reported in the literature, TFTs performance are worse than standard higher temperature dielectrics because of high interface trap density due to low temperature. In order to improve the TFT performance, high-k materials are preferable. However, most of the high-k materials show a polycrystalline structure and small bandgap, hence the leakage current is high and breakdown voltage is low. These problems can be overcome through a combination of high-k but low bandgap and low-k but large bandgap materials. In this study, TiO_2 is chosen as a high-k material because of very high dielectric constant of ~ 80, and Al_2O_3 is chosen as a low-k material because of large bandgap of 8.7 eV. For optimization of high dielectric constant and low leakage current, a combinatorial thin film sputtering approach is used for the synthesis and characterization of Al_2O_3-TiO_2 high-k dielectrics because a combinatorial thin film sputtering approach can yield a wide range of compositions via a single co-sputter deposition process. The composition ranges of the films are simulated using a co-sputtering simulation and compared favorably to compositions measured by the wavelength dispersive spectrometer (WDS). The TFTs are fabricated with a bottom-gate staggered structure using amorphous indium gallium zinc oxide (a-IGZO) and In_2O_3 as the semiconducting active layer. Standard I-V and C-V data on the dielectric multilayers will be compared as a function of composition and finally, the TFTs' performance will be presented according to the relative contents of TiO_2 and Al_2O_3.

TC-ThP2 Fabrication and Characterization of Sub-micron OTFT Using Ink Jet Combined Imprint Process, ***K. Kim****, N. Kwon, I. Chung*, Sungkyunkwan Univ., Republic of Korea

We fabricated sub-micron organic thin film transistors on polyethersulphone (PES) substrate using ink jet printing combined with an imprint method. The channel lengths of OTFTs were in the range between 500 nm and 1 um. 6,13-bis(triisopropylsilylethynyl) (TIPS) pentacene was used as an active material and Polyvinyl alcohol (PVA) was chosen as a gate insulator. TIPS pentacene was printed by jetting onto the confined channels which were prepared using imprinting. The surface of confined channel was modified by UV irradiation in order to enhance the crystallinity of tips pentacene. The physical properties were analyzed using SPM, SEM, and XRD. The electrical properties were extracted from the transfer characteristics which were measured using Keithley-4200.

TC-ThP3 Study on Multiple Stacked 6,13-bis(triisopropylsilylethynyl) (TIPS) Pentacene for Improved Organic Thin Film Transistor, ***S. Lee***, Sungkyunkwan Univ. & Samsung Mobile Display, Republic of Korea, *J.J. Han, K. Kim, I.J. Bae, I. Chung*, Sungkyunkwan Univ., Republic of Korea

We found that the crystallization of TIPS pentacene thin film plays an important role in determining the electrical property of organic thin film transistor (OTFT). Ink jetted TIPS pentacene film reveals 2 different types of grains namely due to the coffee strain effect. The better electrical properties were obtained from the OTFTs with bigger grains that had been possible due to the multiple stacked TIPS pentacene layer. Poly-4-vinylphenol (PVP) was used as a gate insulator, and Au electrode was evaporated using a shadow mask. The channel lengths of OTFTs with the bottom gate structure were 20-50 um. The physical properties of the TIPS pentacene films were analyzed using optical microscope (OM), x-ray diffraction (XRD) and secondary electron microscopy (SEM). The electric characteristics of OTFT were obtained using Keithley- 4200.

TC-ThP4 Catalyst-assisted Pulsed Laser Deposition of Tin (IV) Oxide on Si Substrates: Growth Evolution of Low-dimensional Nanostructures, ***K.T. Leung***, University of Waterloo, Canada

Single-crystalline nanostructures of SnO_2 have been grown with the aid of size-controllable gold nanoisland catalysts supported on a Si substrate by using the Pulsed Laser Deposition (PLD) method. By changing the gas atmosphere and manipulating the deposition at a relatively low substrate temperature (500-700°C), we produce faceted nanobricks, nanograss, and nanoribbons on oxidized Si and cubic nanoparticles on H-terminated Si. Scanning electron microscopy clearly shows the faceted morphology of these one-dimensional and zero-dimensional nanostructures and suggests a vapour-solid and a vapour-liquid-solid growth mechanisms for nanoparticles and nanobricks and for nanograss and nanoribbons, respectively. X-ray diffraction results reveal the tetragonal crystalline phase of the SnO_2 nanostructures, and the relative intensity ratios obtained for different peaks further show a preferred growth orientation of (101) for the nanoparticles and nanobricks, and of (200) for the nanograss and nanoribbons. For nanograss and nanoribbons, transmission electron microscopy confirms the single-crystalline nature of these nanostructures, and the corresponding high-resolution and selected area electron diffraction data illustrate their different growth orientations that generally lead to the preferred growth directions as inferred from the corresponding X-ray diffraction data. We have also recently used Helium Ion Microscopy to elucidate not only the intricate surface details but also the growth evolution of these SnO_2 nanostructures. These results demonstrate the versatility of the catalyst-assisted PLD technique in depositing a variety of SnO_2 nanostructures, which can be easily optimized and/or modified by appropriate doping within the PLD method for producing desirable optoelectronic, magnetic, gas-sensing, and semiconducting properties for emerging applications.

TC-ThP5 From Discrete and Hollow Nanocavities to the Formation of Continuous Indium-Filled Indium Oxide Nanotubes, *M. Kumar*, South Dakota State University, *B.R. Mehta*, ***J.P. Singh***, Indian Institute of Technology-Delhi, India

The growth mechanism for single crystalline indium oxide nanotu be is still under debate in scientific community. The mechanism was proposed for the growth of nanotubes based on the growth parameters dependent morphological transformation from discrete and hollow nanocavities in nanowires to continuous indium-filled indium oxide nanotubes. The gas flow rate induced change in indium partial pressure and hence supersaturation during reaction of species on substrate decides the growth of two different nanostructures. We discussed a unified growth mechanism based on vapor-solid growth followed by the out diffusion or in-diffusion of metal indium depending on it's partial pressure during growth. The out diffusion of indium resulted discrete and hexagonal nanocavity enclosed with minimum surface energy planes, {111} while the higher partial pressure of indium support the merging of discreet nanocavities into continuous connecting and filled with In metal.

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