Fundamentals and Technology of Multifunctional Materials and Devices
Room Royal Palm 4-6 - Session C2-3

Thin Films for Active Devices

Moderators: Vanya DarakchievaMarco Cremona, Pontificia Universidade Católica do Rio de Janeiro, Junichi Nomoto, Kochi University of Technology, Japan,

2:30pm **C2-3-4 High Dielectric Constant of Polymer-inorganic Nanocomposites as Gate Dielectrics for Organic Thin Film Transistor Applications***, **Cheng-Huai Yang**, Y Yu, C Chiu,* Ming Chi University of Technology, Taiwan

Organic thin film transistors (OTFTs) based on pentacene and hydroxyl-containing polyimide-zirconium dioxide (PI-ZrO_2) hybrid films were fabricated on silicon substrate in which the PI and ZrO_2 were as the semiconductor and the gate dielectrics, respectively. Zirconium butoxide ($Zr(OBu)_4$) was used as the precursor to synthesize nano-sized ZrO_2 colloid through the hydrolysis and condensation reaction in a sol-gel process. Then, PI-ZrO_2 hybrid solution was synthesized from a condensation reaction between hydroxyl-containing ZrO_2 and polyimide, followed by a spin coating to form the PI-ZrO_2 dielectric composites. Cyclic olefin copolymer (COC) was used as a modify layer to enhance the interface property between the semiconductor and the dielectric layer. In addition, PffBT4T-2OD was replaced by pentacene as semiconductor to expect a good performance on device. The thermal, optical, surface, dielectric, and electrical properties of the PI-ZrO_2 dielectric composites were investigated and correlated to ZrO_2 content due to the dispersion and aggregation behaviors of the nanoparticles. The PI-ZrO_2 hybrid dielectrics showed the tunable insulating properties, including high dielectric constants, high capacitances, and low leakage current densities. Besides, the bottom-gate top-contact OTFTs based on the PI-ZrO_2 hybrid dielectrics PZ30% and PZ30%-COC showed the best performance with the near zero threshold voltage and the field-effect mobility (μ) about 1.12 $cm^2V^{-1}s^{-1}$ and 3.25 $cm^2V^{-1}s^{-1}$ and the current on/off ratio (I_{on}/I_{off}) about $1.2x10^4$ and $1.2x10^6$, respectively. Based on the above results, PI-ZrO_2 hybrid dielectrics were synthesized and the OTFTs based on the PI-ZrO2 hybrid dielectrics and pentacene were fabricated successfully. The best performance for OTFTs was obtained when the ZrO2 content in hybrid films was 30%.

2:50pm **C2-3-5 Different Nitridation Condition Influence NBTI in FinFETs***, **Hsi-Wen Liu**, T Chang,* National Sun Yat-Sen University, Taiwan

This research uses different Nitridation condition to investigate negative bias instability (NBTI) in p-channel fin field effect transistors (p-FinFETs). We find that low Nitridation temperature device suppress NBTI compare to high Nitridation temperature device. It is because that nitrogen located at Si/SiON interface more at higher temperature. Beside, we compare spike and soak post-Nitridation anneal. We find soak one can suppress NBTI effectively.

3:10pm **C2-3-6 Analysis of Abnormal Transconductance in Body-tied PD SOI n-MOSFETs***, **Chien-Yu Lin**, T Chang,* National Sun Yat-sen University, Taiwan

This letter investigates the mechanism of abnormal transconductance (Gm) and abnormal charge pumping current (ICP) in body-tied partially-depleted silicon-on-insulator n-channel metal-oxide-semiconductor field effect transistors. The ICP second hump region increases with channel length, yet is not affected by channel width. The cross-sectional view of the L-gate structure along the width direction demonstrates that a part of the poly gate area near the body contact is covered by a P^+ implant, inducing a parasitic channel under the P^+ poly gate. This parasitic channel leads to the abnormal Gm and ICP hump, and such mechanism is further verified by body floating devices.

3:30pm **C2-3-7 Influence of the Ammonia Hardening on the Properties of Sol-Gel Thin Film Coatings***, **Christophe Boscher**, J Avice, H Piombini, X Dieudonné, P Belleville, K Vallé,* CEA, France

Introduction

The Laser Megajoule is one of the most important parts of simulation program of CEA. Its purpose is to create the thermodynamic conditions of a nuclear fusion at the laboratory scale. The LMJ is made of different large aperture components (typically 40X40 cm^2) in order to amplify and transport light and then to concentrate it on a millimetric microtarget.

To minimize the parasit reflexions and to maximize the energy on the target, all the components must be treated with an antireflective thin film coating. This surface treatment is realized thanks to a sol-gel process associated with a liquid phase coating.

2. Colloïdal silica antireflective coating

The sol-gel solution used for the antireflective treatment is a colloidal suspension synthetized by sol-gel route inspired of Stöber method [1]. The synthesis results of the hydrolyze-condensation of tetraethyl orthosilicate in an alcoholic solution. Then, it is deposited on optical components by spin/dip-coating or laminar induction method.

The cohesion between particles and the adherence on the substrate are relatively weak, that ' s why the coating is little adherent mechanically.

To increase the cohesion of these colloïdal thin films, a chemical modification of the nanoparticles is achieved thanks to a post-processing using ammonia vapors, called "ammonia hardening process" [2].

This process permits a modification of the nanocontact chemical bonds from Van Der Walls to Hydrogen & Covalent bonds.

The purpose of this study is to follow these modifications during the ammonia hardening process. We use different characterization techniques as IR spectroscopy or surface tension measurements (chemical changes inside the layer or in the surface), UV/VIS spectroscopy (refractive index or thickness modifications) and an acoustic pico-second method (mechanical changes).

3. Conclusion

The precise knowledge of the ammonia hardening mechanisms has permitted to reduce the duration of the ammonia hardening step. This point is crucial in order to increase the production rate in an industrial process.

4. Bibliography

[1] ***Werner Stöber*, *Arthur Fink*, *Ernst Bohn* "*controlled growth* of *monodisperse silica spheres*in the*micron size range" journal*of *colloid*and*interface science*, *volume 26*, *issue 1*, January 1968, *pages 62-69* Growth of Monodisperse Silica Spheres**

[2] Philippe F. Belleville and Herve G. Floc h, "Ammonia hardening of porous silica antireflective coatings", Proc. SPIE 2288, pp25-3, (1994).

3:50pm **C2-3-8 Miniaturized Shape Memory (SMA) Bimorph Actuators with Polymer Layers***, **Cory Knick**, G Smith, N Jankowski, C Morris,* US Army Research Laboratory, USA

Shape-memory alloy (SMA) actuators based on nickel-titanium (NiTi, or NITINOL) are promising candidates for miniaturized sensors and actuators in MEMS applications [1]. Thermal processing constraints currently limit monolithic SMA actuator integration for example in soft body micro robotics or onto soft polymer substrates. Other electronic materials can also degrade when exposed to typical NiTi crystallization temperatures in excess of 450 °C. Historically, NiTi crystallization requires sputter or anneal temperatures of 450 °C or more so there is a desire to obtain shape memory effects at lower processing temperatures.

To motivate the mating of polymer and crystallized NiTi SMA layers, we developed and carried out the microfabrication of a simple, yet novel, shape memory (SMA) bimorph actuator, outlined in Figure 1, and based on previous deposition and micromachining processes of NiTi on platinum [2, 3]. By following crystallized 270 nm NiTi SMA with a 1 micron photosensitive polymer layer, we created a bimorph with a large coefficient of thermal expansion (CTE) mismatch (>40 ppm/°C) allowing significant yet predictable curvature upon release. An analytical strain/curvature model [4] predicted the radius of curvature to within 10% as shown in Figure 2, and resulted in a measured radius of curvature down to 50 µm for an actuator that folded flat upon actuation.

The full benefits of combining SMA materials with polymers can only be realized without the constraint of high temperature crystallization coming before polymer deposition. To this end, we carried out experiments to investigate the crystallization of amorphous NiTi using a Novacentrix pulse forge additive manufacturing tool. This tool is used to sinter metal powders on standard polymer substrates, and our goal was to assess whether the as-deposited amorphous NiTi could be crystallized using intense (>10,000 W/cm^2) microsecond bursts of light. We tested experimental stacks of sputtered, amorphous submicron thick films of NiTi on Si and on 1.2 micron films of polyimide. We developed thermal models used to predict transient temperature profiles in the NiTi film/substrate stacks, using differential scanning calorimetry (DSC) scans on substrate-released NiTi films to determine specific heat values. Using these values, models and preliminary experiments using x-ray diffraction analysis indicate that the pulse forge method may be a novel technique to crystallize shape memory materials while limiting thermal exposure of adjacent polymer layers or other electronic materials.

4:10pm **C2-3-9 Investigating Degradation Behaviors Induced by Hot Carriers in the ESL in Amorphous InGaZnO TFTs with Different Electrode Materials and Structure***, Chung-I Yang,* National Chiao Tung University, Taiwan*; T Chang,* National Sun Yat-Sen University, Taiwan

We discuss the indium gallium zinc oxide (InGaZnO) thin film transistor

hot carrier effect, the etching terminating layer contact window type element because

of source pole and drain pole excess electrode leads to electron injection in drain pole

excess electricity and lower channel etch stop layer, and the injected electron will be

confined to the excess electrode position, such electronic injection state gate source

capacitance curves is due to the phenomenon of two-stage uplift. The relationship

between the thermal field emission activation energy and the work function of the

metal materials can be found by the amount of different electrode materials.

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