Thin Film
Room: Hall D - Session TF-ThP

Thin Films Poster Session

TF-ThP1 Synthesis of Multilayered MgO/Ag/MgO Thin Films in the (001) and (111) Orientations by Pulsed Laser Deposition, ***Daniel Velazquez***, *R. Seibert, Z. Yusof, L. Spentzouris, J. Terry*, Illinois Institute of Technology

Crystalline, highly oriented MgO/Ag/MgO ultrathin films were grown in the crystallographic orientations (001) and (111) via pulsed laser deposition at 150 °C and 170 °C, respectively. Buffer Ag films ~40 nm thick on MgO(001) and Si(111) single crystal substrates were used to assist the epitaxial growth of the MgO/Ag/MgO multilayer structures in the corresponding orientation. The formation of multilayers was monitored in-situ via reflection high-energy electron diffraction. The physical and chemical structure of the films is further characterized via X-ray photoelectron spectroscopy and scanning tunneling microscopy.

TF-ThP2 Development of CNT/Ni Composite Plated Films with Excellent Mechanical Properties, ***Shoko Yamada***, Aichi Institute of Technology, Japan, *H. Ito,* Aichi Institute of Technology, *A. Matsumuro*, Aichi Institute of Technology, Japan

Surface modification of forming many kinds of films must be one of the most important technologies. For especially many kinds of plating methods are already established and easy processing to the product of complicated forms. Furthermore, the composite plating which contains many kinds of small particles in the film are also fabricated and it contributes to the further improvement in the characteristic.

In this study, we focused on development of Ni composite plated films reinforced by dispersed multi-walled CNT with 50 nm in the diameter and several μm in the length using the ultrasonic vibration. An ordinary electroplating method was applied at room temperature. CNT/Ni composite plated film was examined under the conventional plating conditions of pH 4.5-4.7 using a Ni plate as an anode and a Cu plate as a cathode. The mixing weight concentrations of CNT were changed in the range of 0-0.1 wt.%CNT to the weight of the plating bath. It is necessary to prevent from aggregation of CNT in composite plated films because the aggregation parts of CNT must surely cause a loss of strength of the materials. In order to distribute CNT molecules in the plating solution, the ultrasonic vibrations was applied for 1 h before the plating process. The operation conditions was set constant as follows; the bias voltage of 3.7 V, the current density of 3.0 A/dm^2 and the plating time of 10 minutes. Thickness of plated film obtained was about 40 μm. Fabrication of CNT/Ni composite films of all mixing weight ratio plated on a Cu plate was confirmed with flat surfaces. But the remarkable condensation parts were observed at the surface at the weight ratio of 0.1 wt.%CNT. The X-ray diffraction experiments clearly indicated no formation of any compound between Ni metal and CNT, because only Ni crystalline diffraction patterns for all CNT concentrations were identified. Vickers hardness tests showed that the hardness increased with the increase of concentration up to 310 Hv of 0.07 wt.%CNT, and decreased after that. This maximum hardness was about twice of the value of the pure Ni plated film. The decrease of hardness over the concentration of 0.07 wt.%CNT should be due to existence of softer aggregate part CNT in the composite films. The friction and abrasion characteristics were also estimated using by a pin-on-disk tester under the load of 0.5 N with a stainless steel pin. It was clarified that the friction coefficient of the composite film with concentration of 0.07 wt.%CNT decreased to 0.5 in comparison with pure Ni coating of 0.8 and showed an unobservable abrasion mark.

From the above results, industrial validity of this study was surely able to be found out.

TF-ThP3 Fabrication of Dispersed C_{60} Molecules/TiN Composite Film Using by Simultaneous Deposition Method with Both Heating Evaporation and Sputtering, ***Yuki Ishiyama***, *A. Matsumuro*, Aichi Institute of Technology, Japan

We fabricated dispersed C_{60} molecules/Al nano-composite thin films using by a conventional vacuum evaporation method. The microstructural characterization of the films obtained clarified the uniform dispersion of C_{60} molecules in Al based film. Nano-indentation hardness of Al-1.0 wt.%C_{60} showed increase up to 3 times larger than that of Al film. These results clearly indicated that dispersion of C_{60} molecules in the conventional films contributes to drastic improvement in mechanical properties.

In this study, we tried to establish the synthesis technology of the composite thin films containing dispersed C_{60} molecules in order to apply practical uses in the industry fields. We focused on conventional high hardness TiN films fabricated using by RF magnetron sputtering method. For the purpose of evaporating C_{60} molecules, the heating evaporator was equipped directly below the substrate of existing RF magnetron sputtering chamber due to prevent from the influence of plasma. It was possible to control the deposition rates of two kinds of evaporation sources to become the predetermined compositions separately.

TiN films with constant thickness of 100 nm were deposited on Si(100) water-cooled substrates using by the RF magnetron sputtering deposition method for 30 minutes. The concentration of C_{60} molecule powder was changed in the range from 0.5 to 50 wt.%, and the evaporation temperature was controlled in the range of 473-673 K. The structure analyses of all nano-composite films prepared by X-ray diffraction method showed TiN crystalline structure, and FT-IR analysis clarified the existence of C_{60} molecules contained in TiN films. Nano-indentation studies showed that the hardness of the composite film of 2.0 wt.%C_{60}/TiN showed the maximum hardness of 18 GPa and this value was increased up to 50 % larger than that of TiN film.

The present results clearly indicate that the conventional hard thin films prepared by RF sputtering should be also effective to synthesize remarkable hard composite thin films by dispersing C_{60} molecules. Therefore, this study let us know the bright future view of development of the innovative high-hard composite thin films reinforced using by C_{60} molecules.

TF-ThP4 Improved Reflectance of M/Si Bilayers for Extreme Ultraviolet Lithography Reflective Mirror, ***Chao-Te Lee***, *D. Chiang, P.-K. Chiu, H.-P. Chen, C.N. Hsiao*, National Applied Research Laboratories, Taiwan, Republic of China

The periodic Mo/Si bilayers were deposited on Si substrate by RF magnetron sputtering with Mo and Si targets. The Mo/Si bilayers were designed for reflectivity at the wavelength of 13.5 nm. The effects of substrate temperature range (T=20 to 25 ℃, and 20 to 55℃) on the microstructure, surface roughness and reflectance of Mo/Si bilayers were investigated by atomic force microscopy (AFM), high resolution transmission electron microscopy (HRTEM), and a spectrometer. The AFM measurements showed the Mo/Si bilayers to have a uniform morphology with a very low surface roughness value under 0.2 nm. It was found that the interface between Mo and Si film was clearly discriminated at substrate temperature range 20 to 25 ℃ by HRTEM. The reflectivity of Mo/Si bilayers was 47.9% at substrate temperature range 20 to 55 ℃, and 63.3% at substrate temperature range 20 to 25 ℃, respectively. The incident angle increased from 33.47o to 46.13o with substrate temperature range. The improved reflectance and incident angle shifted were attributed to form the clearly interface and vary the film thickness.

TF-ThP8 Characterization of Fluorine-doped Al_2O_3 Films Deposited by High-Power Impulse Magnetron Sputtering, ***Bohuei Liao***, Instrument Technology Research Center, Taiwan, Republic of China, *C.N. Hsiao,* ITRC, NARL, Taiwan, Republic of China, *C.C. Lee*, National Central University, Taiwan, Republic of China

Fluorine-doped Al_2O_3 films were deposited by high-power impulse magnetron sputtering with an Al metal target at room temperature. In order to obtain better optical and mechanical properties, films were investigated under different duty cycle and different ratios of O_2 to CF_4 gas. The optical properties in deep ultraviolet range, microstructure, surface roughness, and crystalline structure, of fluorine-doped Al_2O_3 films have been studied. The fluorine-doped Al_2O_3 films deposited with 45/555 duty cycle and 0.6 sccm CF_4 has lowest extinction coefficient (5×10^{-4})and highest refractive index (1.70) at 193 nm. Besides, the fluorine-doped Al_2O_3 films reveal a dense and amorphous structure.

TF-ThP9 Formation of ZnGaON Films Prepared by Two Types of co-Sputtering using ZnO or Zn Target and their Optical Properties, ***Junichi Iwata***, *Y. Hirano, H. Sase, H. Katsumata*, Meiji University, Japan

ZnO is an interesting wurtzitic semiconducting material with a wide band-gap of 3.3 eV. It has been reported that the reduction of the optical band-gap down to 2.4 eV was observed from $(ZnO)_x(GaN)_{1-x}$ powders with x = 0.81[1]. Moreover, optical band-gap of nitrogen doped ZnO (ZnON) films decreased from 3.26 to 0.9 eV with increasing the N concentration[2], while that of $Zn_{1-x}Ga_xO$ films was reported to be engineered from 3.3 to 4.9 eV by varying the Ga content[3]. From these facts, we believe that the band-gap of ZnGaON can be widely controllable from 0.9 to 4.9 eV by changing their chemical composition. In these previous reports, however, there have been few observations on their luminescence properties. The purpose of this

study is to form ZnGaON thin films with various optical band-gaps. The substrates used in this study were c-axis sapphire substrates or glass substrates. ZnGaON thin films were deposited on these substrates by two kinds of radio frequency (RF) magnetron co-sputtering methods. One is co-sputtering (a) of GaN tablets and a ZnO target in N_2/O_2 gas flow, in which the GaN tablets were placed on the ZnO target and the number of GaN tablets (N_{GaN}) was varied from 0 to 3. The other is co-sputtering (b) of Ga_2O_3 tablets and Zn target in Ar/N_2 gas flow, in which the Ga_2O_3 tablets were placed on the Zn target. Samples were subsequently subjected to NH_3 treatment at 500 °C for nitridation in former co-sputtering (a) and N_2 annealing at 500 °C for improvement of crystallinity in latter co-sputtering (b). These samples were characterized by X-ray diffraction (XRD), energy dispersive X-ray spectrometry (EDS), optical transmittance and photoluminescence (PL). First of all, we show the characterization results of films prepared by co-sputtering (a). XRD analysis showed that the crystalline quality of ZnGaON films became worse with increasing N_{GaN}. EDS results revealed that nitrogen doping concentration in ZnGaON films was increased only by NH_3 treatment. Optical band-gap of ZnGaON films became wider from 3.29 to 3.51 eV with increasing N_{GaN} from 0 to 3 due to Burnstein-Moss shift. PL spectra of ZnO films showed band-to-band emission at 380nm, while those of ZnGaON films exhibited a broad and weak peak centered at 530 nm, which results from oxygen interstitial (O_i). On the other hands, optical band-gap of ZnON films prepared by co-sputtering (b) without Ga_2O_3 tablets decreased to 1.18 eV, probably due to formation of Zn_3N_2.

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TF-ThP14 Growth and Characterization of Aluminum Oxide for M/I/S Junctions, ***Zachary Barcikowski***, University of Maryland, College Park, *J. Pomeroy*, National Institute of Standards and Technology (NIST)

In progress towards spin polarization measurements, we are using a unique ultra-high vacuum (UHV) deposition chamber equipped with electron gun deposition sources, sputter deposition, and plasma oxidation to fabricate shadow-mask defined tunnel junctions. The formation of the tunnel barrier is one of the most crucial processes in junction fabrication which makes the development of an optimal growth recipe a vital step. While varying plasma oxidation process parameters, we will be growing aluminum oxide thin films as a tunnel barrier for metal/insulator/superconductor junctions. Optical spectra of the oxidation plasma and electrical characterization of the resulting junctions will be used to elucidate optimum growth conditions for our aluminum oxide tunnel barriers. The aforementioned data and experimental details will be discussed in this presentation.

TF-ThP15 Low–Temperature Thin Dielectric Films Obtained by ECR–CVD for Application in Non–Volatile Memories, ***David Mateos***, *J.A. Diniz*, University of Campinas, Brazil, *S.N. Mestanza Muñoz*, Federal University of ABC, Brazil, *N. Nedev, M.A. Curiel Alvarez*, Autonomous University of Baja California, Mexico, *M. Mederos Vidal*, Federal University of ABC, Brazil, *B. Valdez, G. Montero*, Autonomous University of Baja California, Mexico

In this work we present results for two types of thin films deposited by ECR–CVD: silicon oxide (SiO_2) and hydrogenated amorphous silicon (a–Si:H) with thicknesses of about 6–8nm and 3–4nm respectively. SiO_2/a–Si:H and SiO_2/a–Si:H/SiO_2 structures for potential application in Non–Volatile Memories, were deposited on p–type (100) c–Si wafers under the following conditions: a gas pressure of 2.0mTorr, an applied ECR microwave (frequency of 2.45GHz) with power of 250Watts and a substrate temperature of 20°C. The precursor gases used for SiO_2 deposition were 2% of SiH_4 diluted in Ar, Ar and O_2 with flows of 125, 5 and 2.5sccm, respectively. The a–Si:H layers were deposited without oxygen using the same SiH_4 and Ar flows. The films were subjected to furnace annealing in N_2 at temperatures in the 800–1100°C range for 60min. Different oxygen and silicon incorporation into the films were extracted using Energy Dispersive X–ray (EDX) analysis (Fig1). Information for the layer thicknesses and optical properties was carried out by Single Wavelength Ellipsometry (SWE) λ~638nm. The thickness measured was 7–11nm and 9–20nm for two and three layers, respectively. Refractive index (n) values between 1.46–1.53 that were obtained are greater than stoichiometric silicon oxide (n=1.457) reported in the literature, indicating formation of thin films rich in silicon. MOS capacitors were fabricated by r.f. sputtering of Al as top (d~0.5 μm) and back contacts. These capacitors were sintered at 450°C in forming gas (92%N_2 and 8%H_2) for 5, 10 and 20min. Electrical characterization was carried out by Capacitance–Voltage (C-V) measurements. The increase of the low temperature annealing time, leads to an improvement of the SiO_2/Si interface seen as an increase of the slope of the high frequency C–V dependence. The capacitance variation in accumulation (C_{acc}) is in the range of 160–180pF for two layer capacitors which correspond to a thickness of 6–7nm (Fig2). In the same way for three layers the variation of C_{acc} is larger and the thickness calculated is 11–17nm (Fig3). The obtained values are in agreement with the expected thickness determined by SWE. Three–layer MOS capacitors annealing in forming gas for 20min showed hysteresis in their C–V measurements with ramps varying from negative to positive voltages and back. The flat–band Voltage shift (ΔV_{FB}) obtained for capacitors annealed at 800°C and 1000°C were: -2.7V to -2.13V and -4.3V to -2.48V showing an hysteresis window of 0.57V and 1.82V, respectively (Fig4). By the other hand for two–region structures do not present hysteresis (Fig5) which means that three-layer structures could be a possible application as memory devices.

TF-ThP16 MOCVD Growth of 2-D MgZnO Wurtzite Thin Films for Solar-blind Detector Applications, ***Judith Reynolds***, *J.E. Rowe, L. Reynolds, D.E. Aspnes*, North Carolina State University

We report the MOCVD growth of doped thin 2-D MgZnO films on c-plane sapphire substrates for solar-blind detector applications. Spectroscopic ellipsometry (SE), X-ray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS) are used to determine the composition. The carrier gas is N_2. For pure ZnO, the precursors are diethylzinc (DEZ) and nitrous oxide (N_2O). When growing *p*-type material, 3% nitric oxide (NO) in N_2 provides N ions in the +2 oxidation state needed for doping, and growth occurs as a two-step process monitored in real time by the SE. In the first step, we use a low Zn partial pressure to induce V_{Zn} formation. Because V_{Zn} energies are low for Fermi levels from mid-gap to the conduction band edge, and because the absorption energy for N_{Zn} is 0.08 eV for the hexagonal close packed site of the Zn-polar surface, this allows the N to incorporate at Zn sites as N_{Zn}. In the second step, we use a high Zn partial pressure to drive the formation of oxygen vacancies (V_O). Growth is then followed by an appropriate annealing sequence. While substitutional N on the O sublattice is a deep acceptor, we find that acceptor complexes involving N, H and V_{Zn} can provide p-type ZnO films with a hole concentration of ~10^{18} cm^{-3} at room temperature. For MgZnO growth, we use bis-cyclopentadienyl magnesium (BcMg) in addition to DEZ, N_2O, and NO. Although we deposit MgZnO, films of a quality that we consider acceptable have not yet been produced owing to the large parameter space of temperature, precursor flows, and gas pressure.

TF-ThP17 Investigation of RF-sputtered Tin Sulfide Thin Films with *In Situ* and Post-Deposition Heating for Photovoltaic Applications, *R.E. Banai*, ***Jacob Cordell***, *J.R. Nasr, R.E. Urena, N.J. Tanen, J.R.S. Brownson, M.W. Horn*, Penn State University

Tin (II) Monosulfide (SnS) has become an interesting new material for thin film photovoltaics (PV). The optoelectronic properties indicate that SnS is a suitable material for PV. Its high absorption coefficient, greater than 10^4 cm^{-1}, and band gap near 1.3 eV are well matched with the solar spectrum. SnS also has a carrier concentration greater than 10^{15} cm^{-3} and potential to be both n-type and p-type. With recent success in achieving 4% efficiency, SnS-based devices demonstrated their potential. However, the success comes with extensive optimization of each layer in the device, suggesting that further understanding of SnS is crucial to improving performance.

Sulfur is more volatile than tin and despite strong Sn-S bonds in tin sulfide compounds, sulfur loss to the gas phase while annealing in a vacuum environment. Therefore, it is important to start with a sulfur-rich thin film prior to annealing. Annealing of sulfur-rich sputtered tin sulfide thin films has not been done before. This work will investigate the optoelectronic properties, composition and morphology of annealed, sputtered tin sulfide thin films. Specifically, we will investigate the change in phase and improvement in material quality as a result of post-deposition heat treatments.

Tin sulfide thin films are sputtered on glass and silicon substrates from a distance of 11.5 cm at 115 W with a Ar chamber pressure of 10 mTorr. The sputter target was a 3" SnS_2 with 99.999% purity (LTS Research Laboratories, Inc.). SnS_x samples are deposited at room temperature and 150ºC. These samples are then annealed some under medium vacuum (<$2x10^{-6}$ Torr) in the deposition chamber without breaking vacuum at 200, 300, and 400°C.

Preliminary results show promise for high-quality SnS thin films. Significantly improved crystallinity was seen in sulfur-rich thin films annealed at 400ºC for 30 minutes. Morphology is not the same for film deposited with and without substrate heating, although both film exhibit a uniform SnS phase as determined by X-ray diffraction. Longer anneal times are expected to further improve crystal quality. Reasonable resistivities are seen in these annealed thin films. The presentation will include details on producing high-quality SnS thin films as well as detailed results of optoelectronic properties, composition and morphology.

TF-ThP19 Sputter-Deposited Carbon Fuses in Long-Term Digital Data Storage, ***Jacob Bagley***, *H. Wang, A. Diwan, R.C. Davis, B. Lunt, M.R. Linford*, Brigham Young University

Solid-state digital data storage devices with the capacity of storing data for 1000 years are being developed. One implementation of this effort is a device that employs a series of carbon fuses. This study explores whether sputtering can yield sufficiently conductive carbon for this application. We hypothesize that reducing the amount of oxygen in the sputtered carbon may sufficiently improve its conductivity. Accordingly, carbon is deposited by DC magnetron sputtering. Sputtering conditions studied include argon pressures of 5 mTorr and 7 mTorr and powers of 250 W and 400 W. Titanium is also co-sputtered at 150 W with a closed shutter to act as an oxygen getter. The oxygen contents of the films were measured by X-ray photoelectron spectroscopy (XPS), and their conductivity was measured with a 500 V megaohmmeter. The oxygen content of the films slightly decreases with decreasing argon pressure and decreasing power on the carbon target. Use of the titanium getter significantly decreases the oxygen contents of the films. However, no significant increase in conductivity is observed, i.e., the deposited carbon is not conductive enough for our purposes. We conclude that sputtered carbon, as deposited with our current system, is not suitable for our devices.

TF-ThP20 Low Hydrogen Silicon Nitride Films Deposited by Plasma Enhanced Chemical Vapor Deposition, ***Erica Douglas***, *A. Starbuck, C. DeRose*, Sandia National Laboratories

Due to exceptional material properties, such as refractive index and others, the use of silicon nitride (SiN) as an optical waveguide has become common. SiN films are used in many applications, from gate dielectrics to encapsulation layers. However, the use of SiN as a waveguide is greatly affected by hydrogen incorporation, particularly at telecommunication wavelengths of ~1550 nm.

Hydrogen incorporation for plasma enhanced chemical vapor deposition (PECVD) of SiN_x is a due to the Si-H species from the use of SiH_4 as well as the standard precursor NH_3 for the N component for SiN_x. The resulting hydrogen bonds, both Si-H species and N-H species, result in absorption and thus loss in the telecommunication spectrum. In particular, the N-H bond has high absorption around 1550 nm.

Previous studies have investigated the use of N_2 as a replacement precursor for NH_3 for low-hydrogen PECVD SiN_x.[1,2] However, these studies have only investigated a few process parameters and their effect on the optical characteristics of the film. In our investigation, a detailed study was performed on a production PECVD system to look at the effect of SiH_4 flow, NH_3 flow, N_2 flow, ratios of all precursors, chamber pressure, and RF bias. The relative hydrogen content was measured for all process parameters through Fourier transform infrared spectroscopy (FTIR). Additionally, we measured the refractive index (from 375 nm to 1675 nm), deposition rate, uniformity, and stress of the SiN_x films. We are able to not only tune the relative hydrogen content of the film, but the uniformity, stress and refractive index independently, in order to fabricate SiN_x optical waveguides for photonic applications.

It was observed that although substituting N_2 in place of NH_3 for the source of N in SiN_x resulted in lower relative hydrogen content, it greatly affected the refractive index and stress of the film resulting in a film that is not ideal for photonic integrated circuits. In order to balance these film properties, we were able to exploit other process parameters, such as chamber pressure and RF bias, in order to tune the film. We also measured the insertion loss of SiN_x optical waveguides with select SiN_x films in order to further understand the role of different film properties.

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TF-ThP21 Enhancing the Water Vapour Barrier Properties of Polymer Substrates with ALD Metal Oxide Films, ***Karyn Jarvis***, *G. Griffiths*, Australian Nuclear Science and Technology Organisation (ANSTO), Australia, *L. Hyde*, Melbourne Centre for Nanofabrication (MCN), Australia, *P. Evans, G. Triani*, Australian Nuclear Science and Technology Organisation (ANSTO), Australia

Polymer substrates are used for flexible organic electronics due to being lightweight, cheap, transparent and printable in continuous roll to roll manufacturing technology. However, a significant disadvantage of these materials is their high gas/vapour permeability. A permeation barrier is therefore essential when using polymer substrates in organic electronics to reduce both oxygen and moisture ingress to an acceptable level. Films deposited by atomic layer deposition (ALD) have shown to improve the barrier properties of polymeric films [1-2]. In the present study, single alumina (Al_2O_3) films were deposited onto one surface of PET substrates (Multapex, biaxially oriented, 75 µm thick) using thermal and plasma enhanced ALD. Films with thicknesses in the range of 7 - 25 nm were deposited at 100 or 120°C. The water vapour transmission rate (WVTR) of the ALD films was determined predominately by tritium permeation, but was also measured using the MOCON and Ca-tests for comparison. Thermally grown 20 nm thick alumina films were also deposited onto PET and PEN substrates with thicknesses of 75 and 125 µm to evaluate the effect of substrate type and thickness on WVTR. In addition, several mixed oxide structures such as alumina/hafnia and alumina/titania were also investigated to examine their potential for further decreasing the WVTR. Characterisation of the ALD grown films was carried out using X-ray photoelectron spectroscopy, atomic force microscopy and optical microscopy. For single Al_2O_3 layers, film thickness and deposition temperature influenced the WVTR. The WVTR decreased with increasing film thickness and deposition temperature. The deposition of ALD metal oxide films was successful in reducing water permeation through polymer substrates, demonstrating the potential of these coatings as a barrier technology for organic electronics over wide range of polymer based products.

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TF-ThP22 Sol-Gel Deposited TiO_2 Thin Films for Propane Gas Sensors, ***Ismael Garduño-Wilches***, *A. Maldonado Álvarez*, CINVESTAV-IPN, México, *D.R. Acosta-Najarro*, Universidad Nacional Autonoma de México

Titanium-dioxide films are produced by the dip coating method, using a solution of 2-propanol and titanium isopropoxide in a concentration of 0.17M and an immersion speed of 0.122 cm/s. Films with different thickness are obtained by changing the number of immersion cycles. Analysis results indicate that the obtained films present the TiO_2 anatase structure when treated at 400 °C for 3 hrs, the film thickness ranged from 20nm to 150 nm and the rate deposition is of 18 nm/cycle.

Gas sensing studies indicate that at a work temperatures of 300 °C sensors present a significant change in electrical resistance. When analyzing sensors sensitivity as a function of propane concentration and film thickness a two-regime behavior is observed, being the sensitivity independent of the film thickness when partial pressures are above 400 ppm, and thickness dependant at lower partial pressures. The maximum sensitivity is obtained in the range from 5 ppm to 300 ppm for the film grown with 5 immersion cycles.

TF-ThP23 Investigation of Optical Property and Crystalline of the Sliver Mirror in the 35 Krad Co-60 Radiation Environment, ***Po-Kai Chiu***, *D. Chiang, C.T. Lee, Y.W. Lin, C.N. Hsiao*, Instrument Technology Research Center, National Applied Research Laboratories, Taiwan, Republic of China

This study investigated the optical design of silver mirror and effected of optical properties in the radiation environment. In different optical designed by Macleod software was studied in the same radiation environment. The optical properties were measured by the integrating sphere spectrophotometer and material properties by X-ray diffraction instrument. After the 35 Krad Co-60 radiation testing, the titanium dioxide film, silicon dioxide film, pure chromium and silver film could efficient reduce the damage of the B270 substrate by radiation. In the visible light, the titanium dioxide film had smaller spectral absorption about 0.5% at 450 nm and about 25 nm spectral drift. In the metal film,ΔT% in visible light of the sliver film was about 0.5% and chrome film about 1.5%. So, the radiation resistance of silver film was better than chrome film. By X-Ray diffraction analysis showed that the crystalline of silver film would be slightly improved by exposure to radiation.

TF-ThP25 Effect of Mg Doping Concentration on Resistance Switching Behavior of Oxygen Deficient Mg-doped Al_2O_3 Films, ***Kyumin Lee***, *Y. Kim, T. Kim, H. Na, H. Sohn*, Yonsei University, Korea

In this study, the effect of Mg doping concentration on the resistance switching behavior of Al_2O_3 films was investigated in conjunction with an analysis of the chemical bonding states. Mg doping concentration is increased from 0 to 8.6% with increasing Mg gun power. In micro-structure, the Al_2O_3 and Mg-doped Al_2O_3 films have amorphous structure in all conditions. In non-lattice oxygen, the concentration of non-lattice oxygen is increased with increasing Mg doping concentration in Al_2O_3 films. In order to identify the effect of only non-lattice oxygen

concentration without crystal structure change, the resistance switching characteristics such as operating current, forming electric field, endurance, and retention was compared. The operating current and uniformity of endurance is increased with increasing Mg doping concentration. And also the conduction mechanism and activation energy from Poole-Frenkel equation of resistance switching characteristics of Mg-doped Al_2O_3 films was investigated. The activation energy is decreased with increasing non-lattice oxygen concentration because non-lattice oxygen is defect in Al_2O_3 films. From these findings, the resistance switching characteristics are influenced by non-lattice oxygen concentration.

TF-ThP26 Failure of Semiclassical Models to Describe Resistivity Size Effect in sub 15nm Films., ***Daniel Yates***, University of Central Florida, *X. Liu*, Carnegie Mellon University, *D. Choi*, Korea Railroad Research Institute, Republic of Korea, *P. Schelling*, University of Central Florida, *K. Barmak*, Columbia University, *K.R. Coffey*, University of Central Florida

Previous work in copper thin films with thickness > 30nm demonstrated excellent agreement with the semiclassical models of the resistivity size effect. Using the same methodology developed for Cu, electron scattering at surfaces and grain boundaries in polycrystalline Ni, Ru, and W films was examined. 2-200 nm thick films were prepared via DC magnetron sputtering onto thermally oxidized silicon wafers. Films with thicknesses below 10nm were encapsulated in 0.5nm thick layers of Ta to improve film stability.

Films were annealed in the range of 200°C to 900°C in Ar+3% H_2. They were characterized using X-ray reflectivity, Rutherford backscatter spectrometry, and transmission electron microscopy with precession electron diffraction techniques to measure thickness, grain size, and film continuity. Resistivity was measured using the Van Der Pauw method.

The contributions of surface and grain boundary scattering were assessed using the semiclassical models of Fuchs-Sondheimer and Mayadas-Shatzkes. Systematic deviations from model predictions were observed for films less than approximately 15nm thick in all three metals. The complex Fermi surfaces of these metals result in a variety of Fermi velocities, as several bands cross the Fermi level. This complexity may be a likely cause for the failure of the semiclassical models, which consider only an average mean free path value. The deviations are most pronounced in the thinnest films.

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