Thursday Evening Poster Sessions

Manufacturing Science and Technology
Room: Hall D - Session MS-ThP

Manufacturing Science and Technology Poster Session

MS-ThP1 Development of Dispersed C_{60}-Molecules/Al Composite Materials Using Nanocrystalline Al Powder Synthesized by Pulsed Wire Evaporation Method, ***Daiki Muto***, *A. Matsumuro*, Aichi Institute of Technology, Japan

Carbon dioxide reduction is global environmental issues are urgent for all over worlds. As one of the problem solving methods, it is necessary to develop innovative higher specific strength materials. From this viewpoint, we focused on synthesis of new C_{60}/Al composites materials.

In this study, C_{60} /Al composite materials were prepared by a usual press sintering method. We must prevent from aggregation of C_{60} powders in composite materials because the aggregation parts would surely cause a loss of strength of the materials. In order to distribute C_{60} molecules around Al powders, ultrasonic vibration was applied with isopropyl alcohol as a solvent for 1 h when both powders were mixed before sintering composite materials. The powder for press sintering was prepared to dry in a furnace at about 340 K for 10 minutes. The average diameter of Al powders and the crystal grain size were about 100 nm measured by SEM and several tens of nm estimated by X-ray diffraction method, respectively. The composite materials with uniform dispersion of C_{60} were fabricated by press sintering process under the condition of the applied pressure of 1 GPa and the temperature of 723K for 4 hour in Ar gas atmosphere. We investigated the optimal condition of the composite materials as changing composition rates from 0 to 5.0 wt.%C_{60}.

In our results, we could not find remarkable aggregated parts of C_{60} powders mixing powders up to 1.0 wt.%C_{60} powders by SEM observations, and the microstructures must be considered to dispersion of C_{60} molecules around Al powders. All specimens sintered were looked like uniform bulk materials. The densities of composite materials decreased according to the increase in the composition rate of C_{60}, and decreased from 2.7×10^3 kg/m^3 of Al to 2.36×10^3 kg/m^3 of 1.0 wt.%C_{60}. X-ray diffraction method showed only Al crystalline structure for all composite materials and FT-IR analysis clarified the existence of C_{60} molecules in composite materials. Vickers hardness of Al material showed drastic increase up to 300 Hv in comparison with about 60 Hv of commercial Al materials due to nanocrystallization effect. The composite material with 1.0 wt.%C_{60} showed the maximum value of 340 Hv. The specific strength of 1.0wt.%C_{60} was increased up to 5.4 times comparing with those of industrially Al materials. This maximum specific strength of this study clarified surprisingly enhancement of over 3 times in comparison with that of commercial Mg alloys. Therefore, dispersed C_{60}-molecules/Al-matrix composite materials with nanocrystalline powder give us dreams of development for innovative high specific strength materials.

MS-ThP2 Reliability Improvement in Metal Hard-mask based Cu/Ultra Low-K Interconnects by Damage Reduction, ***MingDa Hsieh***, United Microelectronics Corporation, Taiwan, Republic of China

Among the several factors of the circuit reliability degradation, Low-k damage is one of the major factors. The purpose of this paper is to improve reliability by reducing the damage during etching. Low-k damage has been quantified by analysis of measured k value, Relief etch, Thermal Desorption Spectroscopy (TDS) and Leakage Current. Based on all the results, we can infer that Low dissociation Ash and low power PET reduces low-k damage and improves VRDB.

MS-ThP4 Electrical Contact Resistance Characteristics of 28nm HK/MG Gate-Last Process with Advanced Manufacture Technology, ***Ching-Pin Hsu***, *C.L. Lu, Y.C. Lin, F.Y. Chang, K.Y. Liao, C.L. Chen,* United Microelectronics Corporation, Taiwan, Republic of China, *L. Chen, C. Huang, C. Chen,* Tokyo Electron Taiwan, Republic of China, *J. Tsai, Y. Hsiao, A. Wang*, Hermes Epitek, Taiwan, Republic of China

The High-k Metal Gate (HK/MG) Contact Rc is an extremely key factor to dominate the HK/MG MOS transistor device performance. Therefore the HK/MG Contact Rc stability and controllability become relatively important. However, the influence of HK/MG Contact Rc stability would come from the Contact etching process especially. This paper presents HK/MG Contact Rc performance evaluation to achieve the goal of mass production with the control of process flow time, and with several difference treatment methods of Dry and Wet process.

MS-ThP5 Double Patterning Critical Open of Dual Damascene Approach for 14nm Node Beyond, ***ShihChun Tsai***, United Microelectronics Corporation, Taiwan, Republic of China

Double patterning lithography (DPL)

technologies have become a must for 32nm

nodes below. Currently have 2 approaches for DPL:

Self-aligned double patterning(SADP) and litho

etch litho etch(LELE).In this paper, we focus on

LELE induce issue, and present an etching solution

to solve this critical VIA open issue.

MS-ThP6 Vertical Poly Dimethylsiloxane (PDMS) Fluidic Channel Fabrication by Rapid Prototyping, ***Yu-Hsin Lin***, *P.L. Chen,* NARL, Taiwan, Republic of China, *Y.S. Lin,* Hungkuang UniversityHungkuang University, *Y.H. Tang, C.C. Yang, M.H. Shiao, C.N. Hsiao*, NARL, Taiwan, Republic of China

This paper describes a rapid fabrication process in vertical poly dimethylsiloxane (PDMS) fluidic device for bio-applications by Rapid Prototyping (RP). Rapid Prototyping is fast, easy and mask-less process to build the 3-dimension structures. The process allows for the stacking of many PDMS channel layers to realize vertical fluidic device. In this paper, the vertical PDMS fluidic device is consisted two PDMS fluidic channel layer included top fluidic channel layer and bottom fluidic channel layer. The fluidic channel structures is manufactured by Rapid Prototyping then glued on a glass substrate with UV curing as a master. The Teflon-like film is coated on the surface of master. The PDMS is cast against the master producing molded channel layer. After curing process, the PDMS replica is easily peeled off from the master. The top and bottom fluidic channel layers are aligned and bonded together by oxygen treatment to form vertical fluidic device. The performance of vertical fluidic device prepared using this rapid prototyping technique has been demonstrated by fabricating a miniaturized bio-application system.

MS-ThP7 Fabrication of Deeply Striped Pattern Structures by ICP-RIE Technique on the Lithium Niobate Substrate, ***Chun-Ming Chang***, *M.-J. Huang, J.Y. Su, N.N. Chu, C.N. Hsiao, M.H. Shiao*, ITRC, NARL Taiwan, Republic of China

In this study, striped pattern structures with linewidth of 5 μm and 10 μm on lithium niobate ($LiNbO_3$) substrate were fabricated by the inductively coupled plasma reactive ion etching (ICP-RIE) technique for the waveguide applications. Pure nickel (Ni) thin film of 300 nm in thickness used as the etching mask and was deposited by sputtering technique on the $LiNbO_3$ substrate with a 20 nm adhesion layer of nickel-chrome (Ni-Cr) alloy with a composition ratio of 80/ 20. The $LiNbO_3$ substrates with the Ni etching mask was etched in the boron trichloride (BCl_3)/ Argon (Ar) mixed etching gas which flow ratio was controlled at 30/ 5 SCCM and the working pressures controlled at 30 mTorr, 40 mTorr, 50 mTorr, and 60 mTorr, respectively. The ICP powers were controlled from 100 W to 600 W and the RF powers were controlled from 100 W to 500 W during 45 minutes of each ICP-RIE process.

From the experimental results, it can be found that the DC bias (-V) decreases with the working pressure, and increases with the ICP powers and the RF powers. Under suitable ICP-RIE etching parameters, the structure with 6 μm in depth and the sidewall angle of 80° was successfully prepared on the the surface of $LiNbO_3$ substrate, which the etch selectivity ratio was 10 and the etching rate was 70 nm/ min.

MS-ThP9 Fabrication of Micro ring Resonators for Nonlinear Optics Applications using Silicon Nitride Film Deposited at Room Temperature Overcoming the Stress Limitation, ***Adriano Ricardo do Nascimento Jr.***, *L.T. Tiago Manera, J.A. Alexandre Diniz, A.R. R. Silva, M.V. Vinicius Puydinger dos Santos,* University of Campinas, Brazil, *A.C. Cerqueira S. Jr.,* National Institute of Telecommunications, Brazil, *L.A. A. M. Barea, N.C. C. Frateschi*, University of Campinas, Brazil

Silicon nitride (Si_xN_y) films deposited by low-pressure electron cyclotron resonance plasma enhanced chemical vapor deposition (ECR-CVD) at room temperature are proposed for nonlinear optics applications in the telecommunications C-band. Due to the high silicon nitride nonlinearity, these films recently have also been used for nonlinear optics [1]. For nonlinear applications such as the generation of frequency combs, the waveguide needs a zero dispersion point in the middle of C-band, requesting large waveguide area. Unfortunately, these thick Si_xN_y films (>400 nm) have high stress and suffer from catastrophic cracking, which

reduces the device efficiency [2]. Using numerical simulations it was demonstrated that for refractive index (η) values greater than 2, the area of the waveguide with zero dispersion point at $\lambda = 1.55$ μm is greatly reduced.

By varying deposition parameters, such as gas pressure (4-6 mTorr) and Si/N ratio (0.62-1.25), Si_xN_y films with high deposition rate and high refractive index was obtained. In many cases, for larger pressure values a considerable increase in the deposition rate is observed, and for lower N_2 flow was observed a large increase of η (due to high concentration of Si). However, increasing the gas pressure, a reduction of η due the incorporation of hydrogen in the film was also observed.

A Si-rich silicon nitride layer with 730 nm of thickness, refractive index of 2, high deposition rate, low hydrogen concentration and roughness average of 0.52 nm was deposited above a Si/SiO_2 wafer during 100 minutes using ECR-CVD and applied for fabrication of nonlinear microring resonators**.** Due to the low temperature deposition, no thermal stress was observed in the Si_xN_y film, allowing a large thickness (obtained with only one deposition process) . The main advantage of higher Si concentration in this film is the higher values of η and the absence of losses caused by two-photon absorption, responsible for the introduction of additional losses in silicon based waveguides [3].

After experimental measurements, microring resonators having a radius of 60 μm, presented an equidistant Free Spectral Range and a Q-factor of $4x10^3$ was achieved, showing the high efficiency of the device. Finally, using the deposition process at low temperature and controlling the process parameters such as pressure and gas ratios, a remarkable free thermal stress silicon nitride film was obtained, overcoming the stress limitation of thick silicon nitride films.

[1] J. S. Levy *et al.*, Nat. Photonics, vol. 4, no. 1, pp. 37–40, 2009.

[2] K. Luke *et al.*, Opt. Express 21, 22829-22833, 2013.

[3] H. K. Tsang *et al.*, Appl. Phys. Lett., vol. 80, no. 3, p. 416, 2002.

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