MEMS and NEMS Group
Room Hall B - Session MN-ThP
MEMS and NEMS Group Poster Session

MN-ThP-1 The Ni-Co Micro-porous Array with High Dimensional Accuracy Control by Electroforming Process, ***YuHsin Lin***, *H Wen,* ITRC,NARL, Taiwan, Republic of China; *C Tsia,* NCTU, Taiwan, Republic of China; *M Wang, N Chu, C Chen, C Hsiao,* ITRC,NARL, Taiwan, Republic of China

In this project, the Ni-Co micro-porous array membrane for ultra-high sensitivity gas detector for nano particle distribution measurement is developed for cascade impactor application. The thick film lithography and electroforming technologies have been integrated, here. The dimension of micro-porous can be precisely controlled and reproducible. Finally, the micro-porous metal film will be integrated with base structure by laser welding technology. The component is used for cascade impactor equipment.

The fabrication process of Ni-Co micro-porous array membrane is used MEMS process. Here, the 6 inch silicon wafer as a substrate is used. The Cr/Au with 30/200nm thickness as a seedlayer is made by Sputter. The gold has good electrical conductivity to get well Ni-Co thickness uniformity at electroforming process. The AZ6112 photoresist is patterned on the seedlayer by lithography. The Cr/Au is etched to define a circle pattern. Then the thick photoresist SU8 pillar with 150μm thickness is fabricated at the center of the circle seedlayer pattern. The diameter of SU8 at the bottom is used to control the final diameter of Ni-Co porous. The Ni-Co membrane with 130μm thickness has been fabricated by electroforming process. Finally, the SU8 pillar is removed and the Ni-Co porous membrane is peel off from substrate. The Ni-Co micro-porous array membrane with good hole's dimension control have successful fabricated.

***Keywords*: Micro-porous, Electroforming, cascade impactor**

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MN-ThP-2 Reactive Etching of AlGaN using BCl_3 and Ar/BCl_3, ***Meng-Kun Wang***, *Y Lin, C Hsiao, C Chen, J Su, N Chu, C Lee,* ITRC,NARL, Taiwan, Republic of China

In this paper, we study the self- limited reaction of Ar/BCl_3 and AlGaN. We performed AlGaN surface oxidation reaction with oxygen ions before Ar/BCl_3 etching on the AlGaN surface, and used the same power of inductively coupled plasma (ICP), the same working pressure, and the same The etching time was compared to the difference in etching rate of AlGaN between Ar/BCl_3 and BCl_3. And using Atomic force microscopy (AFM) and scanning electron microscopy (SEM) to observe the change and morphology of the surface roughness after etching. The results show that the mixed gas of Ar/BCl_3 has a faster etching rate, the etching rate is about 4.79 nm/min, and the etching rate of BCl_3 gas is slow, and the etching rate is about 0.90 nm/min.

MN-ThP-3 Self-Assembled Poly(Ethylene Glycol) Initated Spatial And Temporal Profiling Of Micro Devices For Selectively Growing Human Liver Cancer Cells, ***Juhi Jaiswal***, *M Dhayal,* IIT (BHU), Varanasi, India

Polymeric materials are widely used in fabrication of microfluidic systems for use in biomedical domain due to good optical transparency, non-toxicity, biocompatibility and good reversible sealing properties with other materials. Among these polydimethylsiloxane (PDMS) is one of the most commonly used in micro-systems for biomedical applications and plasma treatment has been extensively used to modify hydrophobic PDMS surface for irreversible bonding. However the stability of such modification is transient which can be recovered in less a shorter time while there are limitations in engineering desired surface structures and chemistry of these . In this work, we have developed a new process by which we able to control and estimated spatial and temporal reorganization of atoms in PDMS which may help us to construct a model system for understanding role of recovery of hydrophobic nature and achieving desired surface properties. Chemical composition analysis of fabricated micro-devices were done with the angle resolved X-ray photoelectron spectroscopy (XPS). Variation in atomic % proportion has been estimated from time resolved semi-in-situ angle resolved XPS measurements. Further we have developed a self-assembly process with poly(ethylene glycol) silane by which we able to chemically stabilized and functionalized both surface hydrophilicity and chemical nature of the micro devices fabricated by soft lithography process and used it for selectively growing human liver cancer cells.

MN-ThP-4 III-V_Si Wafer Bonding using Silicon Oxide Interlayer, ***WoongSun Lim***, *S Jung,* Korea Advanced Nano Fab Center, Republic of Korea; *S Hwang,* Korea Advancnced Nano Fab Center, Republic of Korea; *G Yeom,* Sungkyunkwan University, Republic of Korea

In recently, the interests to integrate III–V based materials with Si can be divided into various application using the material advantages of combining III–V with Si. Therefore, Si wafer to III-V material wafer bonds were performed at low temperatures under 250 °C. The advantage of the low temperatures of these bonds was that wafers with common integrated circuit metals could withstand this temperature without degradation. Also, it is essential to study that low temperature bonding for heterogeneous wafers, because the higher temperature bonding may induce cracks, defects, bowing, and destruction by different thermal expansion coefficients of the heterogeneous wafers.

In this paper, we have investigated low-temperature direct bonding (<250°C) of SiO2 by the surface activation method in plasma. In the method, Oxyzen plasma treatment is used to make a clean surface which has strong bonding ability.The strength of Si oxide to Si oxide bonding prepared at room temperature by the method is equivalent to the bulk strength. Therefore, heating and pressure were applied to the wafers 20 minutes. Si oxide surfaces did not prove to bond spontaneously at room temperature and the bond-strength started to increase only after annealing at about 200°C.

A field emission scanning electron microscopy (FE-SEM) was used to determine the excellent bonding quality of the interface of wafer to wafer bonding. Silicon oxide surface roughness was examined using atomic force microscopy(AFM), respectively. After bonding, the bonded interfaces were evaluated using infrared transmission imaging.

MN-ThP-5 Flexible Nanocomposite Sensors for Biomedical and Energy Harvesting Applications, *A Batra,* ***Bir Bohara***, Alabama A&M University; *J Currie,* NASA

Recently, an increase in demand for sensors for biomedical and ambient energy harvesting applications has led to the development of new hypersensitive smart materials. Biomedical sensors need to be able to be both lightweight, flexible and demonstrate high piezoresistive resolution. In order to meet the pressure sensor requirements for the next generation of prosthetics, efforts were made to develop and characterize multifunctional smart flexible nanocomposite films. The developed improved films could be used for both biomedical and energy harvesting applications. Nanocomposites PVDF and P(VDF-TrFE) film-sensors were fabricated via embedding smart nanocomposites particles along with a variety of carbon nano-particles via the modified solution casting method. The fabrication methods involved in this study aimed at improving the sensitivity of sensors while maintaining flexibility and cost efficiency. The fabricated films were characterized by infrared and dielectric spectroscopy; performance of the sensors was determined via customized strain measurement and energy harvester testing system. Results obtained will be described along with unique features of system developed for performance determination. [This work is funded by NSF-HRD-1546965 grant.]

MN-ThP-6 Comparative Studies of Electrical Behavior of PLZT Thin Film Capacitors using Coplanar and Interplanar Configurations, ***Vaishali Batra***, *R Paul, S Kotru,* The University of Alabama

Lanthanum doped lead zirconate titanate (PLZT) is an interesting ferroelectric material which finds applications in optical MEMS & modulators/transducers, and smart sensors. Recent studies revealing the existence of bulk photovoltaic (PV) effect in this material thereby eliminating the need of fabricating a p-n junction, has generated curiosity among research community to explore this material for future energy/photo sensing applications. Various approaches are being explored to improve the PV output obtained from these devices.

In this work, capacitors with two electrode configurations viz. coplanar and interplanar were used to measure electrical properties. The capacitors were fabricated using thin films of $Pb_{0.95}La_{0.05}Zr_{0.54}Ti_{0.46}O_3$ (PLZT) and top and bottom electrodes of conducting materials. A chemical solution deposition method was used to prepare the films. The capacitance-voltage and polarization-voltage measurements demonstrated that the coplanar configuration shows higher capacitance, lower polarization, and higher coercive voltage as compared to the interplanar configuration. Further, the capacitors with coplanar configuration also demonstrated higher PV

parameters, such as short circuit current density (J_{sc}) and open circuit voltage (V_{oc}). As an example, J_{sc} of 1.86 μA/cm^2 and V_{oc} of -1.1 V were obtained using coplanar configuration with Au electrodes for unpoled devices. Poling showed an improvement in PV parameters for both the coplanar and interplanar configurations, with higher values obtained from the coplanar configuration. After poling, J_{sc} of 1.32 μA/cm^2 and V_{oc} of -0.93 V for interplanar configuration, and J_{sc} of 2.04 μA/cm^2 and V_{oc} of -2.01 V for coplanar configuration were obtained. These results suggest that coplanar configuration is better for measuring the PV properties of PLZT thin film based capacitor structures.

MN-ThP-7 Carbon Nanotube Yarn Based Strain Sensor*, **Maeum Han**, J Lee, J Kim, J Park, D Jung,* Korea Institute of Industrial Technology (KITECH), Republic of Korea

Strain sensor has been used in variety of industrial applications for structural healthy monitoring and biological signal analysis. The fabrication of a highly sensitive strain sensors are underwent many complex and delicate processes, as many fabrication parameters and conditions must be keep equilibrium to achieve good sensor performance, such as high linearity and sensitivity, stable responsivity, fast response time, mechanical durability, and signal processing steps [1].

Carbon based-nano materials such as fullerene, carbon nanotube (CNTs), and graphene have been considered as sensing materials for optical sensor, chemical sensor, physical sensor and environmental sensor, which possess their own strengths and weakness.

Especially, CNTs have been widely employed as sensing species for strain/pressure, gas, temperature, and humidity sensor in recent years. CNT-based sensors were generally fabricated by transferring the individual or bundles of CNTs to the substrates using spin-coating, spraying, dip coating, and inkjet printing methods [1-2].

On the other hand, spin-capable CNTs were reported previously, which simply make transparent conductive CNT webs, ribbon or yarns. The spin-capable CNT forest can give an easy and effective way to fabricate highly-aligned CNT yarn with high flexibility and a electrical conductivity for sensor applications [1-3].

In this paper, we present performance of the CNT yarn based strain sensor. Especially, CNT yarn was associated with stretchable polymers to apply tensile and compressive force. The experimental results reveal that CNT yarn with elastic rubber can be stretch up to 300 %.

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MN-ThP-8 Carbon Nanotube Yarn Based Gas Sensor*, J Lee, M Han, J Kim, **Daewoong Jung**,* Korea Institute of Industrial Technology (KITECH), Republic of Korea

Accuracy and precise measurement of gas values is crucial for recognizing many critical biological and physical signs, as gas values present significant signals for monitoring chemistry, biology, environments and medical industries. Many sensing materials such as metal compounds, composite, nanowires, and polymers, for detecting gas have been investigated, and the merits and demerits of each have been reported [1,2]. Recently, carbon-based nanomaterials, including zero-dimensional fullerenes, one-dimensional carbon nanotubes (CNT), and two-dimensional graphene, have shown probable in gas sensor applications. Many prior works have reported their superior properties, including higher electrical conductivity, mechanical durability and chemical stability, and a larger surface area.

In particularly, CNTs are well known material for sensor applications due to their stable graphite configuration, structural endurance under chemical/physical treatment processes, and mechanical characteristics. Moreover, lots of efforts to realize CNTs as chemical sensor material were performed by many groups previously [3]. They reported that the concentrations of electrons and holes in CNTs play important role in sensitivity of the CNT-based gas sensor. However, although many techniques were introduced to fabricate the CNT-based gas sensors, such device manufacturing processes were intricate and have limited repeatability and reliability, which makes hard them to be commercialized. The CNT yarn was introduced, reported and characterized previously by group using simple dry spinning method [4]. The CNT yarn has good electrical property with a high conductivity, and flexible structural property, and chemical stability. In this work, we develop the ability of CNT yarn for detecting hydrogen and carbon monoxide concentrations. Furthermore, we demonstrate that metal nanoparticles on the surface of CNT yarn highly affect the sensitivity of the CNT yarn-based gas sensor. Therefore, this study focused on the analysis and characteristics of the gas sensor using binary composite as gas sensor.

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Author Index

Bold page numbers indicate presenter