Sym. A : Silicon Process

ETCHING & DEFECTS IN Si

A-THU-17

DEFECT FORMATION MECHANISM OF PROCESS INDUCED TIN-ARC CRACKS, Y. C. PENG and L. J. CHEN(Department of Materials Science and Engineering, National Tsing Hua University, Hsinchu, Taiwan), W. Y. HSIEH and Y. F. HSIEH(United Microelectronics Corporation, Hsinchu, Taiwan)

Aluminum and aluminum alloys have been the most widely used interconnection materials in devices formation for their low resistivity and easy formability. TiN thin films have been widely used as an efficient antireflective coating (ARC) layer on top of the aluminum alloys to reduce the effect of reflective notching and widen the exposure window in photolithographic patterning.

In this study, the TiN-ARC cracks on Al-Cu and Al-Cu-Si systems after development process have been investigated. For the TiN-ARC/Al-Cu system, the high tensile stress due to the thermal expansion mismatch between TiN and Al-Cu thin films raptures the TiN-ARC layer which resulted in the penetration of photoresist developer and etching of the Al. The stress-induced defects were reduced by deposition of thicker TiN-ARC layer. In contrast, for the TiN-ARC/Al-Cu-Si system, the penetration of photoresist developer through the poor coverage of the high aspect ratio small holes induced by Si nodules during cooling was eliminated by the CVD deposited TiN-ARC or the predeposition of interposing Ti layer.

A-THU-18

RADIATION EFFECT ON METAL CONTAMINATED Si DIODES, T. Hakata and H. Ohyama (Kumamoto National College of Technology, 2659-2 Nishigoshi Kumamoto, 861-11 Japan), E. Simoen and C. Claeys (IMEC, Belgium), Y. Takami (Rikkyo University, Japan), H. Sunaga (Takasaki JAERI, Japan), K. Miyahara (Kumamoto University, Japan)

Results are presented of a study on the degradation of performance and induced lattice defects of Si square and gated diodes, subjected to 20-MeV protons and 220-MeV carbon particles. The radiation source dependence of the damage is also discussed by comparing to 1-MeV electron and 1-MeV fast neutron irradiation. Diodes fabricated in CZ and FZ-Si substrates are used, in order to investigate possible oxygen-precipitation hardening effects. Some substrates are contaminated by spiking of copper or iron atoms from a NH_4OH : H_2O_2 : H_2O and HCl solution, respectively. The surface concentrations of the metal contaminants are 2.2 x 10^{12} and 4.1 x 10^{12} atoms/cm^2, as measured by TXRF. The gated diodes have an interdicted structure, with narrow polysilicon fingers in-between the active diode regions and have been used to study the degradation of the interface properties. The diodes are irradiated at room temperature with 20-MeV protons with fluences ranging from 10^{10} to 10^{14} p/cm^2 and with 220-MeV carbon particles. The carbon fluence is varied from 10^{11} to 10^{13} 1/cm^2. Current/voltage and capacitance/voltage characteristics are measured together with the induced deep levels in the Si substrate by DLTS. The influence of the indiffused iron and copper atoms on the device performance is discussed as a function of generation and recombination lifetime. The recovery behavior will also be presented in order to investigate the impact of carbon and oxygen related lattice defects on the device degradation.

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ADVANCED MATERIALS IN SEMICONDUCTORS

A-THU-19

IN-SITU PHOSPHORUS HEAVY DOPING ON $Si_{1-x}Ge_x$ EPITAXIAL GROWTH WITH HIGH Ge FRACTION BY USING LPCVD

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we investigated in-situ phosphorus doping effects on the $Si_{1-x}Ge_x$ epitaxial films with high Ge fraction grown on Si(100) substrate at 550^{o}C by using LPCVD. In a low PH_3 partial pressure region such as below 1 mPa, the deposition rate and the Ge fraction x were constant while the phosphorus doping concentration and the carrier concentration increased proportionally. In a higher PH_3 partial pressure region, the deposition rate, the phosphorus doping concentration and the carrier concentration decreased while the Ge fraction x increased. The surface adsorbed phosphorus atoms suppress more actively the SiH_4 adsorption/reaction as compared with the GeH_4 adsorption/reaction on the surface. Consequently, the deposition rate, the Ge fraction, the dopant concentration and the carrier concentration are largely controlled by the surface coverage of phosphorus atoms in a higher PH_3 partial pressure.

A-THU-20

EPITAXIALLY STABILIZED QUANTUM WELL AND QUANTUM DOT STRUCTURES BASED ON Sn/Si AND $Si_{1-x}Sn_x$/Si HETEROSTRUCTURES, **KYU SUNG MIN** and HARRY A. ATWATER (Thomas J. Watson Laboratory of Applied Physics, Caltech, Pasadena, CA 91125, U.S.A.)

Diamond cubic α-Sn is a semimetal with a zero energy direct gap and band structure calculations have suggested that when alloyed with Si, Sn-rich $Si_{1-x}Sn_x$ alloy system is predicted to have direct and tunable energy gap for Sn composition exceeding some critical concentration. At nanometer-scale, one might also potentially take advantage of quantum carrier confinement to further tune the energy gap over a wide range in the infrared frequency range, for potential application in fabrication of infrared detectors and light emitters. T date, growth of such structures has been hampered by the large lattice mismatch (19%) between Sn and Si (100), and a strong tendency for Sn atoms to segregate to the surface during growth at ordinary Si epitaxy temperatures. We report successful growth and characterization of ultrathin (<5 nm) 2-D quantum well structures based on coherently strained Sn/Si and high Sn concentration (x up to 0.3) $Si_{1-x}Sn_x$/Si structures. Sn incorporation in the amount far in excess of the solubility limit is achieved by an unconventional molecular beam epitaxy technique employing large modulations in substrate temperature and growth rate. We also report a novel approach to making lithography-free nanometer-scale Sn-rich $Si_{1-x}Sn_x$ quantum dots in Si via spinodal decomposition. Characterization of the nanostructures are carried out using *in situ* RHEED, Rutherford backscattering spectrometry, high-resolution X-ray rocking curve analysis, high-resolution TEM, and fourier transform infrared spectroscopy.

THURSDAY