The Fifth IUMRS International Conference on Advanced Materials

IUMRS-ICAM'99

ABSTRACTS

(2)

Beijing, China
June 13- June 18, 1999

Organized By
C-MRS
Chinese Materials Research Society

W-41

TARGET TEMPERATURE SIMULATION DURING PLASMA IMMERSION ION IMPLANTATION

X. B. Tian, T. K. Kwok, X. C. Zeng, P. K. Chu
Dept. of Physics & Materials Science, City University of Hong Kong,
83 Tat Chee Avenue, Kowloon, Hong Kong, SAR, China

The target temperature in the plasma immersion ion implantation (PIII) treatment of metals and semiconductors is crucial as it affects the modified surface properties and structures. An accurate prediction of the target temperature is thus important to PIII processes. We use a two-dimensional fluid model to describe the sheath dynamics when a negative high voltage is imposed on a thin cylindrical target. The equations are solved by the finite difference method to derive the ion distribution, sheath configuration, ion flux to the target, and energy imparted to the substrate by the ions. The calculated heat input is used to predict the temperature rise. The effects of the implantation voltage, pulse duration, pulsing frequency, as well as plasma density on the target temperature will be discussed.

E-mail: Paul K. Chu<paul.chu@cityu.edu.hk>

W-42

HIGH FREQUENCY, LOW VOLTAGE PLASMA IMMERSION ION IMPLANTATION OF SS304 STAINLESS STEEL

X. B. Tian, Z. M. Zeng, B. Y. Tang, P. K. Chu
Dept. of Physics & Materials Science, City University of Hong Kong,
83 Tat Chee Avenue, Kowloon, Hong Kong, SAR, China

Plasma immersion ion implantation (PIII) is an effective technique to produce a thick modified layer in samples possessing an irregular shape. In this paper, we present our special high frequency, low voltage power modulator. The high frequency, low voltage experimental protocols are employed to treat SS304 austenitic stainless steel. Due to the high duty cycle and ion flux, the sample is heated in-situ favoring the treatment process. Analysis of the treated steel samples reveals superior friction, wear, and corrosion properties. This novel technique is especially useful for the surface enhancement of industrial parts with an irregular shape, as the ion-matrix sheath is relatively thin in the low voltage operation and conformal implantation can be more easily achieved.

E-mail: Paul K. Chu<paul.chu@cityu.edu.hk>

W-43

CO-IMPLANTATION OF TITANIUM AND NITROGEN FOR SURFACE MODIFICATION OF AUSTENITIC STAINLESS STEEL USING PLASMA IMMERSION ION IMPLANTATION

X. B. Tian, T. Zhang, P. K. Chu
Dept. of Physics & Materials Science, City University of Hong Kong,
83 Tat Chee Avenue, Kowloon, Hong Kong, SAR, China

Austenitic stainless steels possess excellent corrosion properties and are widely used in the industry. However its low surface hardness being on the order of 200-300 kg/mm^2 and large wear in abrasively stressed parts lead to a short working lifetime. The hardness as well as wear and corrosion behavior of SS304 steels can be improved by nitrogen and titanium plasma immersion ion implantation (PIII). During the process, the nitrogen plasma is ignited by hot filament glow discharge and titanium plasma is simultaneously generated by means of a metal cathodic arc source. Thus, the target in the vacuum chamber is immersed in the plasma and the non-line-of-sight capability of PIII enables the processing of large or irregular-shaped specimens. The nitrogen and titanium ions are co-implanted into the target when a negative high voltage is imposed on the sample. Our experimental results

indicate that the microhardness is increased by 60% and the wear behavior is improved by over 3 orders of magnitude when compared to the untreated samples. The corrosion resistance is slightly better than that of the unimplanted sample. Our results demonstrate the synergistic effects of the coexistence of titanium and nitrogen in the near surface region of the steel samples.

E-mail: Paul K. Chu<paul.chu@cityu.edu.hk>

W-44

INTERFACIAL REACTIONS OF $Ni/Si_{0.76}Ge_{0.24}$ AND $Ni/Si_{1-x-y}Ge_xC_y$ BY PULSED KrF LASER ANNEALING AND VACUUM ANNEALING

Jian-Shing Luo, Wen-Tai Lin, C.Y. Chang†, P.S. Shih†, F.M. Pan††, T.C. Chang††
Department of Materials Science and Engineering, National Cheng Kung University, Tainan, Taiwan
† Department of Electronics Engineering, National Chiao Tung University, Hsinchu, Taiwan
†† National Nano Device Laboratory, Hsinchu, Taiwan

Interfacial reactions of Ni with epitaxial $Si_{0.76}Ge_{0.24}$ and $Si_{1-x-y}Ge_xC_y$ films by vacuum annealing and pulsed KrF laser annealing are studied respectively by transmission electron microscopy in conjunction with energy dispersive spectrometry.

Epitaxial $Si_{0.76}Ge_{0.24}$ films are grown by an ultra-high vacuum chemical vapor deposition system. The epitaxial $Si_{1-x-y}Ge_xC_y$ films are grown by C^+ implantation into the epitaxial $Si_{0.76}Ge_{0.24}$ films at a dose of $1\times10^{16}/cm^2$ and subsequently pulsed KrF laser annealing at an energy density of 0.8-1.0 J/cm^2.

For vacuum annealing the $Ni/Si_{0.76}Ge_{0.24}$ and $Ni/Si_{1-x-y}Ge_xC_y$ films are annealed at a temperature of 200-600°C. In general, the temperatures at which phase transformation and the agglomeration structure occur are higher for $Ni/Si_{1-x-y}Ge_xC_y$ than for $Ni/Si_{0.76}Ge_{0.24}$. For pulsed KrF laser annealing the phase transformation in the $Ni/Si_{1-x-y}Ge_xC_y$ system is slightly sluggished in comparison with that in the $Ni/Si_{0.76}Ge_{0.24}$ system. The present work reveals that C plays a significant effect on delaying silicide formation upon either vacuum annealing or pulsed laser annealing.

E-mail: Wentai Lin<wtlin@mail.ncku.edu.tw>

W-45

PULSED LASER ANNEALING OF $Mo/Si_{0.76}Ge_{0.24}$

Jiang-Shing Luo, Shing-Wei Huang, Wen-Tai Lin, C.Y. Chang†, P.S. Shih†
Department of Materials Science and Engineering, National Cheng Kung University, Tainan, Taiwan
† Department of Electronic Engineering, National Chiao Tung University, Hsinchu, Taiwan

$Si_{1-x}Ge_x$ material offers the promises of greater carrier mobility and band gap engineering, and hence has potential applications in high-speed electronic and optoelectronic devices. The formation of metal-$Si_{1-x}Ge_x$ ohmic or rectifying contacts is required for the device applications. Recently, the interfacial reactions of metals with $Si_{1-x}Ge_x$ films by conventional furnace annealing have been studied. In these reactions, the formation of a ternary phase, *e.g.*, $M(Si_{1-x}Ge_x)_2$, Ge segregation out of the germanosilicide, strain relaxation of the unreacted $Si_{1-x}Ge_x$ film, and the occurrence of agglomeration structure at higher annealing temperatures were generally observed. Refractory metals and refractory metal silicides have a higher temperature stability that makes them attractive candidates for contact metallizations in VLSI circuits. For the interfacial reactions of metal/ $Si_{1-x}Ge_x$ pulsed KrF laser annealing has been found to effectively prevent Ge segregation out of the germanosilicide, the formation of agglomeration structure, and strain relaxation of the unreacted $Si_{1-x}Ge_x$. In this work, pulsed KrF laser annealing as a function of energy density and pulse number is performed on the $Mo/Si_{0.76}Ge_{0.24}$ system. Phase transformation, the distribution of chemical species, and the microstructures of the annealed samples are examined by transmission electron microscopy (TEM) in conjunction with energy dispersive spectrometry (EDS). Meanwhile the strain relaxation of the unreacted $Si_{1-x}Ge_x$ film is observed by x-ray diffraction (XRD) method.

E-mail: Wentai Lin<wtlin@mail.ncku.edu.tw>