VI-M Thin Film Preparation with Chemical Vapor Deposition Using Vacuum Ultraviolet Radiation

Thin-film deposition at temperatures as low as possible is one of the key technologies for next generation of ultra-large scale integrated circuit (ULSI) fabrication. Photon-assisted chemical vapor deposition is a promising way to prepare particularly dielectric thin films. Silicon dioxide and germanium dioxide films have been prepared from tetraethoxysilane (Si–$(OC_2H_5)_4$) and tetraethoxygermanate (Ge–$(OC_2H_5)_4$) with chemical vapor deposition using vacuum ultraviolet radiation.

VI-M-1 Design and Construction of UVSOR-BL4A2 Beam Line for Nano-Structure Processing

TAKEZOE, Noritaka; YANAGIDA, Hideaki[1]; KUROSAWA, Kou; URISU, Tsuneo; NODA, Hideyuki; MEKARU, Harutaka[2]
([1]IMS and Univ. Miyazaki; [2]Himeji Inst. Tech.)

[*Nucl. Instrum. Methods Phys. Res., Sect. A* **467–468**, 1279 (2001)]

Nano structures must open new windows not only for surface physics and chemistry but also for electronic and photonic devices. Synchrotron radiation stimulated surface chemical reactions have been a most promising way to fabricate nano structures, because they offer a process with the advantages of high-site selectivity by core electron excitation and also free-of damage with atomic scale. Since a new beam line with higher flux is required for the processing, we have been designing and constructing UVSOR-BL4A2 beam line for the nano structure fabrication.

VI-M-2 Characterization of SiO_2 Dielectric Films in Photo-Chemical Vapor Deposition Using Vacuum Ultraviolet Excimer Lamp

TOHIKAWA, Kiyohiko[1]; MIYANO, Junichi[1,2]; MOTOYAMA, Yoshikazu[1,2]; YAGI, Yusuke[1]; YANAGIDA, Hideaki[3]; KUROSAWA, Kou; YOKOTANI, Atsushi[2]; SASAKI, Wataru[2]
([1]Miyazaki Oki Electric Co. Ltd.; [2]Univ. Miyazaki; [3]IMS and Univ. Miyazaki)

[*199th Meeting of Electrochemical Society* **241**]

Photo-chemical vapor deposition using vacuum ultraviolet excimer lamp is a novel technology that deposit SiO_2 film at room temperature without the use of high temperature or plasma. The films contain organic impurities coming from tetraethoxysilane (TEOS) used as the precursor. The addition of O_2 molecules to TEOS is found to decrease C–H impurities. We show atomic concentrations in SiO_2 films deposited from TEOS or from TEOS with O_2 or N_2O gas.

VI-M-3 Electrical Properties of SiO_2 films Prepared by VUV Chemical Vapor Deposition

MOTOYAMA, Yoshikazu[1,2]; MIYANO, Junichi[1,2]; TOSHIKAWA, Kiyohiko[2]; YAGI, Yusuke[2]; KUROSAWA, Kou; YOKOTANI, Atsushi[1]; SASAKI, Wataru[1]
([1]Univ. Miyazaki; [2]Miyazaki Oki Electric Co. Ltd.)

[*199th Meeting of Electrochemical Society* **257**]

We have developed a new scheme for SiO_2-film preparation in which tetraethoxyorthosilicate (TEOS: $Si(OC_2H_5)_4$) is photo-dissociated by vacuum ultraviolet Xe_2 excimer radiation (λ = 172 nm) at room temperature. The SiO_2-films are included impurities of C and H atoms and/or molecules. A adding foreign gases included O atom and molecule to TEOS are effective in removal of C atom and/or molecule in SiO_2-film, which bring about excellent gap-filling property, but it is newly included OH impurity. We had knowledge that the electrical properties of SiO_2-films is correlated the amount of OH impurity by FT-IR spectra, C–V and I–V curves. Increase of OH impurity is degraded electrical properties. An only TEOS have not OH impurity, which may be using as the low-k films of next future device processes.

VI-M-4 SiO_2 Film Deposition on Different Substrate Materials by Photo-CVD Using Vacuum Ultraviolet Radiation

MIYANO, Junichi[1,2]; MOTOYAMA, Yoshikazu[1,2]; TOSHIKAWA, Kiyohiko[2]; YAGI, Yusuke[2]; YANAGIDA, Hideaki[3]; KUROSAWA, Kou; YOKOTANI, Atsushi[1]; SASAKI, Wataru[1]
([1]Univ. Miyazaki; [2]Miyazaki Oki Electric Co. Ltd.; [3]IMS and Univ. Miyazaki)

[*199th Meeting of Electrochemical Society* **258**]

We have prepared SiO_2 thin films from tetraethoxy-orthosilicate (TEOS) at room temperature by photo-chemical vapor deposition using a vacuum ultraviolet (VUV) excimer lamp. We showed the affection by adding foreign gases to the raw precursor and by changing substrate materials for the growth rate and thickness uniformity and the reaction mechanism by step coverage in VUV-CVD. The SiO_2 film deposition behaviors by VUV-CVD depend significantly on the presence of ozone and activated oxygen by VUV photons. Then the dependence of substrate materials for the growth rate and thickness uniformity is most remarkable in case of adding O_2.

VI-M-5 Silica Film Preparation by Chemical Vapor Deposition Using Vacuum Ultraviolet Excimer Lamps

KUROSAWA, Kou; TAKEZOE, Noritaka; YANAGIDA, Hideaki; MIYANO, Junichi[2,3]; MOTOYAMA, Yoshikazu[2,3]; KAWASAKI, Yasuhiro[1]; YOKOTANI, Atsushi[2]
([1]IMS and Univ. Miyazaki; [2]Univ. Miyazaki; [3]Miyazaki Oki Electric)

[*Appl. Surf. Sci.* **168**, 37 (2000)]

We have prepared SiO_2 thin films on silicon wafers from tetraethoxyorthosilicate (TEOS; $Si(OC_2H_5)_4$) by photo-chemical vapor deposition (photo-CVD) with the use of various excimer lamps which emit incoherent light at 308 (XeCl), 222 (KrCl), 172 (Xe_2), 146 (Kr_2) and 126 nm (Ar_2). The film deposition is observed at wavelengths shorter than 172 nm. With 10-mW/cm^2 172-nm radiation, the growth rate is 8 nm/min on the room temperature substrate. The deposition efficiency depends on the wavelength and shows the maximum value for 146-nm radiation. Addition of O_2 to TEOS induces inhibition of C and H impurity inclusion in the films.

VI-M-6 GeO_2 and SiO_2 Thin Film Preparation with CVD Using Ultraviolet Excimer Lamps

KUROSAWA, Kou; MAEZONO, Yoshinari[1]; MIYANO, Junichi[1,2]; MOTOYAMA, Yoshikazu[1,2]; YOKOTANI, Atsushi[1]
([1]Univ. Miyazaki; [2]Miyazaki Oki Electric)

[*J. Phys.* **11**, 739 (2001)]

We have prepared SiO_2 and GeO_2 thin films from tetraethoxyorthosilicate (TEOS; $Si(OC_2H_5)_4$) and tetraethoxyorthogermanate (TEOG: $Ge(OC_2H_5)_4$), respectively, by chemical vapor deposition (CVD) assisted by high-energy photons. The photons are supplied from excimer lamps which emit incoherent light at 308 (XeCl), 222 (KrCl), 172 (Xe_2), 146 (Kr_2) and 126 nm (Ar_2). GeO_2 film deposition is observed for all excimer lamps used here, but SiO_2 films are obtained at wavelengths shorter than 172 nm. This is caused by a fact that the bonding energy between Si and O is much higher than that between Ge and O. The deposition rate is around 8nm/min for SiO_2 and 16nm/min for GeO_2 films. The film deposition rate increases with increasing the light intensity and with decreasing substrate temperature.

VI-M-7 Room Temperature Deposition of GeO_2 Thin Films Using Dielectric Barrier Discharge Driven Excimer Lamps

MAEZONO, Yoshinari[1]; YANAGIDA, Hideaki[2]; NISHI, Kota[1]; MIYANO, Junichi[1,3]; YOKOTANI, Atsushi[1]; KUROSAWA, Kou; HISHINUMA, Nobuteru[4]; MATSUNO, Hiromitsu[4]
([1]Univ. Miyazaki; [2]IMS and Univ. Miyazaki; [3]Miyazaki Oki Electric; [4]USHIO Inc.)

[*J. Phys.* **11**, 811 (2001)]

We discuss the fabrication of GeO_2 and GeO_2/SiO_2 films at room temperature by photo-chemical vapor deposition. Excimer lamps were used for the light source, and tetraethothoxyorthosilicate (TEOS) and tetraethoxyorthogermanate (TEOG), as raw materials. We fabricated GeO_2/SiO_2 composite films from a mixed vapor of TEOS and TEOG. The refractive indices of the obtained films showed intermediate values between those of SiO_2 (n = 1.46) and GeO_2 (n = 1.60). The relationship between Ge concentratipon in the films and the refractive indices was examined. We successfully obtained a GeO_2/SiO_2 composite material of higher refractive index than that of similar composites produced by conventional methods.