

206e Metal Organic Chemical Vapor Deposition of Titanium Oxynitride Films Using Tetrakis(Diethylamino)Titanium

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Titanium nitrides and oxides are important materials for several applications due to their excellent protective, optical and electrical properties. Recently, interest in TiN_xO_y films has increased due to their properties dependence on the N/O ratio. For example, oxygen-rich TiN_xO_y films have been used as insulating layers in metal-insulator-metal (MIM) capacitive structures in order to avoid oxide interface layer formation, while nitrogen-rich TiN_xO_y films have been utilized as excellent diffusion barriers. Also, many other useful applications of TiN_xO_y film, such as solar selective absorbers and wear-resistant coatings have been demonstrated.

TiN_xO_y film is commonly deposited by sputtering methods. Requirements for good conformal coverage and low temperature lead to enhanced interest in the chemical vapor deposition of these films. In this study, thin film of titanium oxynitride (TiN_xO_y) were deposited on H-passivated Si(100) substrate using Tetrakis(diethylamido)titanium (TDEAT), and NH₃. The depositions were carried out in a low pressure chemical vapor deposition chamber. The base pressure of the reactor was less than 0.03 torr. The reaction pressure was on the order of 1 torr and the reaction temperature was 300°C. A residual gas analyzer (RGA) was used to monitor the gas phase composition in the reactor. The oxygen source was residual H₂O and O₂ inside chamber, the contents of which were controlled with purge time and monitoring by the RGA.

The structure and composition of both as-deposited and annealed films were studied by using Fourier transform infrared (FTIR) spectroscopy, Raman and Rutherford backscattering spectroscopy (RBS). The surface characteristics of the films were analyzed with x-ray photoelectron spectroscopy (XPS).

Our results show that as-deposited films have amorphous structure. Upon annealing the as-deposited film in air at 750°C for 30 min, the film is oxidized to TiO₂ and crystallized in the rutile structure with little anatase phase. XPS analyses of the as-deposited film show that the surface of the film contains TiN_xO_y, TiO₂, TiN, while the surface is mostly oxidized to TiO₂ after annealing. There is no detectable formation of SiO₂ and Ti-C in the as-deposited film based on FTIR and XPS analyses. The carbon absence in the RBS analysis indicates that the carbon (detected by XPS) is contamination on the wafer surface from the ambient.

TiN_xO_y films with various N/O ratios were deposited by using TDEAT, NH₃ and controlled residual H₂O/O₂ content. The N/O ratio of the as-deposited film was tunable by varying the contents of the residual H₂O and O₂ in the reactor. Further investigation is in progress in order to study whether C-N and amine species are surface contamination or exist in bulk film as well as study their role in the overall system.