F-P-138

Electron conduction mechanism of TiN

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ABSTRACT

Titanium nitride (TiN) is used as an electrode layer in a Si CMOS transistor to prevent the peeling of the W metal. It is also used as a barrier layer to prevent the electromigration and the diffusion of the metal atom into a semiconductor layer. [1] Therefore, it is important to investigate the electrical conduction properties of TiN films systematically. In this conference, we will report the electron conduction mechanism of TiN films.

TiN films were grown on a thermally oxidized Si substrate by the AIP (Arc Ion Plating) and RF (Radio Frequency) sputtering methods in a N_2/Ar mixed gas. The sputtering pressure (0.13 Pa - 0.8 Pa) and the mole fraction of N_2 (12.5 % - 80 %) were changed to investigate the conduction mechanism of TiN films. These deposition conditions correspond to the N_2 partial pressure of 0.016 Pa - 0.32 Pa. The electrical conduction properties were evaluated by Hall measurements from 10K to 300K.

All TiN films showed n-type conductivity. The electrical resistivity of TiN films grown at high N_2 partial pressures decreases with the temperature, while that of TiN films grown at low N_2 partial pressures increases. Even though, in a metal, its electron mobility generally decreases with the temperature due to the phonon scattering, the electron mobility increases with the temperature for TiN films grown at high N_2 partial pressures. As the reason for this, it is thought that the grain boundary between TiN polycrystalline [2] acts as a barrier layer for electrons to show thermally activated electron mobility. On the other hand, the electron concentration of TiN films rapidly decrease at high N_2 partial pressures. This result means that the disordered grain boundary increases with the N_2 partial pressure to trap electrons.

Keywords: titanium nitride, TiN, electrical resistivity, grain boundary

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