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Abstract
In this study, titanium nitride (TiN) films were deposited on p-type Si (100), n-type Si (100), and SiO2 substrates by using precursors of TiCl4 and NH3 in an atomic layer chemical vapor deposition (ALCVD) system. The impurity, resistivity, structure and surface morphology of TiN films were characterized by using AES, four point probe, XRD, TEM, SEM and AFM. The film thickness was measured by α-step and the growth rate was calculated by the number of deposition cycles. The XRD results show that the TiN films are polycrystalline with (200) preferential growth. The cross-sectional microstructure by TEM shows columnar grains in TiN films. The AES spectra show that the chlorine content in TiN films is low and is below the detection limit of AES (<1at.%) as the films were grown at process temperature above 350℃. The film surface is smooth and the roughness, Rms, is below 1 nm. A thermal annealing experiment at oxygen atmosphere shows that the TiN films grown at a higher process temperature possess a better oxidation-resistance ability. The temperature at which TiN can keep from oxidation is about 500℃. The diffusion barrier properties of ALCVD-TiN films for Cu metallization are related to deposition temperature. The Cu/TiN/Si devices still work after 1 h annealing at 700℃ for TiN films grown at process temperature above 450℃. A study on MIM capacitor show that the TiN films are not suitable for bottom electrode of HfOx capacitor because the leakage current of capacitor is large due to HfOx crystallization, which could be caused by TiN bottom electrode.
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