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Characteristics of MOCVD Cobalt on ALD Tantalum Nitride Layer Using H_2/NH_3 Gas as a Reactant

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Microprocessor technology now relies on copper for most of its electrical interconnections. Because of the high diffusivity of copper, Atomic layer deposition (ALD) TaN_x is used as a diffusion barrier to prevent copper diffusion into the Si or SiO_2. Another problem with copper is that it has weak adhesion to most materials. Strong adhesion to copper is an essential characteristic for the new barrier layer because copper films prepared by electroplating peel off easily in the damascene process. Thus adhesion-enhancing layer of cobalt is placed between the TaN_x and the copper. Because, cobalt has strong adhesion to the copper layer and possible seedless electro-plating of copper. Until now, metal film has generally been deposited by physical vapor deposition. However, one draw-back of this method is poor step coverage in applications of ultralarge-scale integration metallization technology. Metal organic chemical vapor deposition (MOCVD) is a good approach to address this problem. In addition, the MOCVD method has several advantages, such as conformal coverage, uniform deposition over large substrate areas and less substrate damage. For this reasons, cobalt films have been studied using MOCVD and various metal-organic precursors. In this study, we used $C_{12}H_{10}O_6(Co)_2$ (dicobalt hexacarbonyl tert-butylacetylene, CCTBA) as a cobalt precursor because of its high vapor pressure and volatility, a liquid state and its excellent thermal stability under normal conditions. Furthermore, the cobalt film was also deposited at various H_2/NH_3 gas ratio(1, 1:1,2,6,8) producing pure cobalt thin films with excellent conformality. Compared to MOCVD cobalt using H_2 gas as a reactant, the cobalt thin film deposited by MOCVD using H_2 with NH_3 showed a low roughness, a low resistivity, and a low carbon impurity. It was found that Co/TaN_x film can achieve a low resistivity of 90 $\mu\Omega$-cm, a low root-mean-square roughness of 0.97 nm at a growth temperature of 150°C and a low carbon impurity of 4~6% carbon concentration.

Keywords: Cu interconnect, MOCVD, CCTBA, Adhesion layer