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THE PROPERTIES OF NITROGEN IMPLANTED TUNGSTEN FILM AS Cu DIFFUSION BARRIER

Chul Soon Kwon*, Dong Joon Kim, and Yong Tae Kim
Semiconductor Materials Laboratory, Korea Institute of Science and Technology, P.O.Box 131, Seoul, Korea
* Micro Process Development, Samsung Electronics, 82-3, Dodang-Dong, Wonmi-Ku, Buchun, Kyunggi-Do, 421-130, Korea

Abstract

In the microelectronics devices, the critical feature size of integrated circuit have been greatly shrunk and consequently, the electrical and physical properties of the metal interconnects such as resistivity and thermal stability strongly limit device performance in multi-level metallization. Recently, copper thin film is widely stuied as a new candidate for a metal interconnect because of its lower electrical resistivity and better electromigration resistance. Therefore, for the successful application of Cu metallization, several problems such as fast diffusivity, high oxidation, and low etching rate of Cu should be solved. In this work, we try to solve the fast diffusion of copper into the silicon interposing a nitrogen implanted W(W-N⁺) thin film between Cu and Si . This nitrogen implanted W thin film is a new diffusion barrier for preventing copper diffusion because the conventional diffusion barriers such as TiN, TiW, TaN and W-N have been deposited by the reactively sputtering processes in nitrogen ambient and the maximum thermally stable temperatures of these materials found be only 600°C. The authors have been studied the thermal stabilities of plasma deposited W nitride thin films as a new diffusion barrier for Al,Au and Pt metallizations. However, we found that the plasma deposited tungsten nitride thin film is not adequate for preventing Cu diffusion into silicon because its physical properties are somewhat unstable after annealing at 7~800°C. On the view point of that the diffusion of Cu atoms can be blocked by the amorphized diffusion barrier, we try to amorphize the W thin films by the nitrogen implantation with dosages of 6×10^{16} ~ $3\times10^{17}/cm^2$. The diffusion barrier properties of this new material have been investigated with the conditions of the nitrogen implantation and compared with the plasma deposited polycrystalline W and the tungsten nitride after depositing Cu film on these diffusion barriers.