Autocatalytic Electroless Cu on Pd activated TaN_x Barrier for ULSI Interconnect

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Cu is being widely used in ULSI metallization process as a replacement for Al due to its lower resistivity and higher electromigration resistance.[1,2] Cu can be deposited by ECD on Cu seed layer which is deposited by PVD. ECD process has the advantages of low tool cost and low processing temperature compared with PVD and CVD processes of Cu.However, ECD technique needs thin Cu seed layer formation by PVD which may cause processing cost rise. Furthermore, ECD process needs external power source for plating and faces uniformity problems in wafers because of IR drop during plating process. Thus, it is necessary to solve these problems by developing plating process of Cu.

Electroless Cu plating does not need formation process of Cu seed layer. Cu can be deposited from an ionic solution on catalytic surface without any external power supply by electroless plating.[3,4] The electroless Cu reaction is an autocatalytic reaction. An activation process is usually needed to start the reaction. Gold, platinum, or palladium is required as catalytic layer for reliable electroless copper deposition, so activation process is a key process for successful electroless copper plating.

Meanwhile, TaN_x is extensively investigated as a diffusion barrier for Cu since it shows high melting temperature and it is thermodynamically stable with Cu. Furthermore, Cu/Ta interface provide excellent adhesion characteristics and Cu films *in-situ* deposited on Ta has stronger (111) texture than those on TiN under same condition. Nevertheless, there have not been few reports on TaN_x barrier for the case of electroless Cu plating.
In this paper, autocatalytic electroless Cu deposition on Pd activated TaN_x (x = 0 – 1) has been investigated with various nitrogen content.

A 2000Å thick PECVD oxide and a 500Å thick sputtered TaN_x barrier layer with varying the gas flow ratio of nitrogen/argon were deposited on p-type (100) Si.. A solution containing $PdCl_2$, HF, HCl, acetic acid, and EDTA was used to activate the surface after clean the surface. Electroless Cu process was performed in a solution containing $CuSO_4$-$5H_2O$, EDTA, TMAH, HCHO, Triton X-100, and 2,2" Diprydyl. Crystallinity and surface roughness of as-deposited TaN_x barriers and electroless Cu were investigated by X-ray diffraction (XRD) and atomic force microscopy (AFM), respectively. Deposition rate of Cu was measured by α-step. The electrical resistivity of electroless Cu films was measured by four-point probe. Surface morphology of TaN_x and Cu films and Pd nuclei density of activated TaN_x films were investigated by FE-SEM and TEM was used to examine the crystalline structures of Pd activated TaN_x barriers. The chemical composition of TaN_x films and Pd nuclei after activation were analyzed by XPS.

Figure 1 shows the surface morphology of Pd activated TaN barrier with 28sccm of nitrogen flow rate. FE-SEM results showed the density of Pd nuclei was increased with increasing nitrogen flow rate which will be shown in the poster session. Figure 2 shows plan view of electroless Cu on Pd activated TaN_x barrier films. The roughness, deposition rate, crystallinity, and electrical resistivity results will be shown in terms of nitrogen content in TaN_x barrier films. Also, the results will be compared with those of electroless Cu on Pd activated TiN barrier films.

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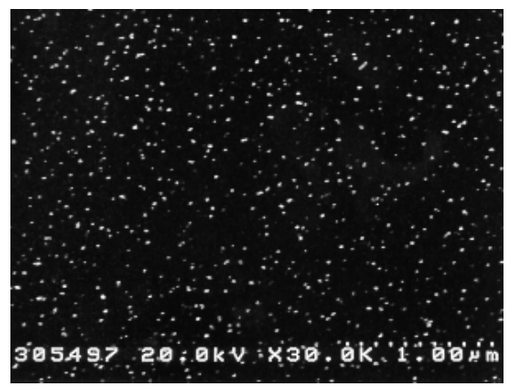

Fig.1 FE-SEM surface morphology of Pd activated TaN (N = 28sccm) barrier film.

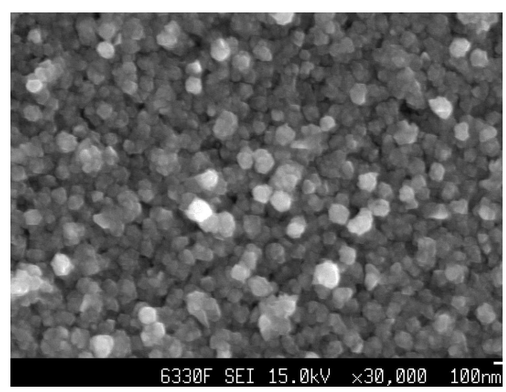

Fig.2 FE-SEM plan view of electroless Cu on Pd activated TaN barrier film.