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新しいRu-CVD/ALD原料を利用した次世代DRAMキャパシタ用電極形成プロセスの開発(2)

Process development for next generation DRAM electrode using a new Ru-CVD/ALD precursor(2)

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Abstract

In this research, process development on Ru electrode fabrication was examined for applying to next generation dynamic random access memory (DRAM) by Ru-CVD/ALD. A new Ru precursor was used to deposite Ru/RuO_2 thin films. *In situ* monitoring technique using light reflectivity measurement was introduced to monitor the initial behavior of Ru/RuO_2 film growth.

Introduction

To successfully integrate DRAM devices, it is important to maintain the certain memory capacitance (25~30 fF) to operate the device, which will be, however, very difficult since the cross-sectional area occupied by the capacitor is reduced as miniaturization. The development of the new high dielectric constant (high-*k*) material (HfO_2, Ta_2O_5, STO, BST) and new electrode materials are essential to maintain the certain capacitance. The new electrode material, Ru, has a large work function (4.71eV) and have conductivity even if it is oxidized. Those characteristics will reduce the leakage current and EOT values of memory capacitor.

Many Ru-CVD/ALD precursors for DRAM capacitor electrodes and Cu interconnect liner layers had been proposed, but none of them could satisfy the process requirements as shown below.

1) Ultra thin (2~3 nm) and continuous film should be grown in high-aspect ratio (~100) features.
2) Incubation period/cycles should be short on SiO_2 and high-*k* materials.
3) Residual carbon impurity should be low to maitain high work function of Ru film.

In the present work, we have introduced new Ru precursor and examined the initial growth behavior of CVD process using *in situ* monitoring method.

Experimental

A newly developed ruthenium precursor was employed and oxygen was used as the oxidizing gas. He was used as the carrier gas and diluent. Si substrate with thermal oxide was used as the substrate. White light was illuminated on the growing surface and the reflected light was measured using a spectrum analyzer. Deposition runs were performed by changing the partial pressures of precursor and oxygen at substrate temperature of 230~240^{o}C.

Result and discussion

Continuous Ru or RuO_2 film was formed using a new Ru precursor. In Ru deposition, RuO_2 film was usually formed using high concentration of oxygen gas and high substrate temperature.

Figure 1 shows the correlation between initial nucleation density and relative reflectivity during 10 min. We can find the deposition time with highest nucleation density and also know the relative reflectivity at that time.

Figure 2 shows the particle size distribution in 15 sec ~ 10 min. We validated when is the best deposition condition, high nucleation density, and small nuclei size, using this method.

Ru-CVD/ALD process development will be continued based on this *in situ* monitoring technique and details will be presented in the conference.

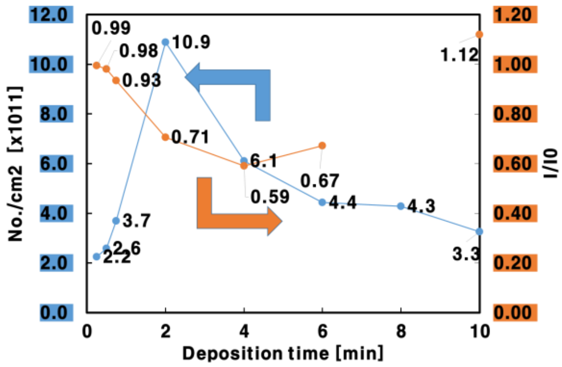

Fig. 1 nucleation density and relative reflectivity in 15 sec ~ 10 min.

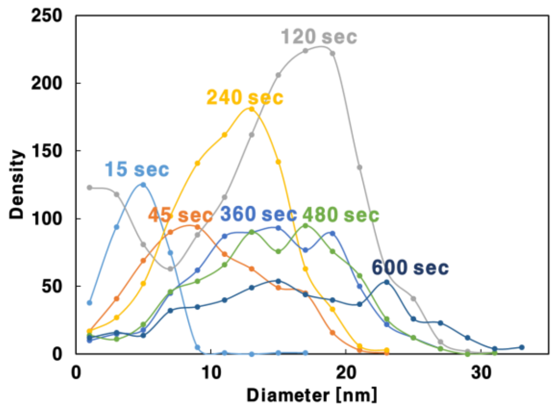

Fig. 2 Particle size distribution in 15 sec ~ 10 min.