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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

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

東大院工　金 泰雄, 百瀬 健, 霜垣 幸浩

The Univ. of Tokyo　Taewoong Kim, Takeshi Momose, and Yukihiro Shimogaki

E-mail: kim@dpe.mm.t.u-tokyo.ac.jp

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 use 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°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 typical example of *in situ* reflected light intensity of Ru/RuO_2 deposition. The incubation period, during which the I/I_0 was not changed, was clearly observed and it can be minimized by modifying the deposition conditions. The maximum intensity is normally showing that continuous film is formed at this point.

Figure 2 shows the reflected light spectrum when the continuous films were formed. The wavelength for the maximum reflection is different for Ru and RuO_2 that make it possible to detect metal or oxide growth during CVD/ALD growth.

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

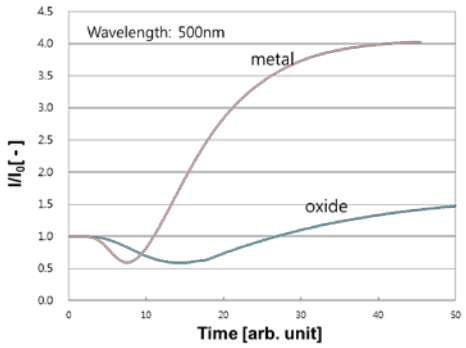

Fig. 1 *In situ* reflected light intensity change during Ru/RuO_2 CVD.

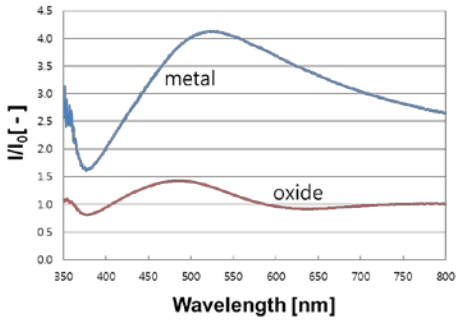

Fig. 2 *In situ* reflected light spectrum from CVD-Ru/RuO_2 surface.