Atomic layer deposition of HfO2 thin film using a novel heteroleptic Ethylenediamine based Hf precursor

Cheol Wan Park, Esssul Shin, Eunjeong Cho, Hyunkee Kim, Ki-yeong Mun, Kyung Sik Lee*, Jung Woo Park*

Hansol Chemical, 873, Gwahak-ro, Bongdong-eup, Wanju_Gun, Jeollabuk-do, 55321, Republic of Korea

Group 4 metal oxide materials such as ZrO_2, TiO_2, and HfO_2 have attracted considerable attention for dielectric materials for microelectronic devices. HfO2 film has an outstanding high-dielectric constant (κ ~ 20-25, t-HfO2) , large band gap Energy (E_g, ~ 6.0 ev) and good thermal stability. For these reason, the HfO_2 thin film applicate microelectronic devices such as the dynamic random access memory (DRAM) capacitors and central processing memory (CPU) gate dielectric application.

In this study, we propose a novel heteroleptic ethylendiamine based Hf precursor namely HEA. The physical characteristic of HEA was investigated by NMR Spectroscopy. Also, we measure the properties of the HfO_2 thin film of HEA against usually used CpTDMAH by thermal atomic layer deposition (TALD).

The evaporation characteristics of HEA and CpTDMAH were carried out in a thermogravimetric analysis (TGA). The amount of residue was about < 0.45 % for HEA, which had a less residue compared to CpTDMAH (< 0.98 %). For both precursors HEA and CpTDMAH, the characteristic self-limiting ALD growth mode was confirmed. The growth rate of HEA was 1.19 Å/cycle with ozone as a reactant gas and showed a Low temperature ALD window in a range of 150–250°C.

HfO_2 thin film properties were investigated by SIMS depth profile and Transmission electron microscope (TEM). The deposited film of HEA represented better step coverage and improved carbon impurity compared to that of CpTDMAH. From this study, The HEA is expected to be advantageous precursor for low temperature thin film deposition technique.

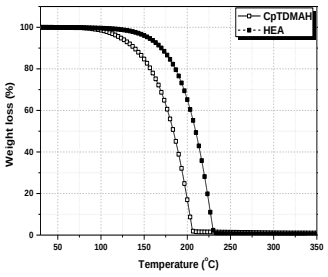

Fig 1. Thermogravimetric analysis

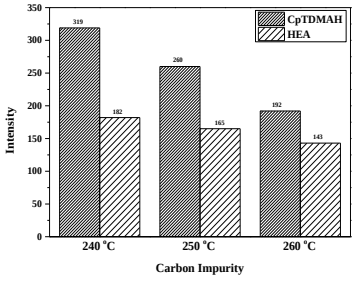

Fig 2. SIMS depth profile

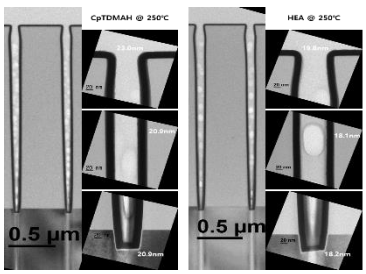

Fig 3. TEM image