Master 2 project proposal

Plasma etching process development of doped HfO_2 for next memory generation

Keywords: plasma etching process, material characterization (AFM, XPS, ellipsometry), HfO_2, Gadolinium, FeRAM

Context :

With the exponential growth in data production and processing due to advancements in electronics and artificial intelligence (AI), the importance of data storage technologies has surged and the need for more advanced memory technologies becomes increasingly critical. Since the recent discovery of ferroelectricity in doped hafnium oxide (HfO_2), Ferroelectric random access memory (FeRAM) has emerged as a promising next-generation memory technology. FeRAM are made up of two metal electrodes surrounding a ferroelectric material (Metal/Ferroelectric/Metal) with two stable polarization states at zero field applied. The use of doped Hafnium oxide as ferroelectric material enables ferroelectric memories to operate at low voltage and high speed. A wide variety of doping species are being considered, including gadolinium, strontium, lanthanum, yttrium and aluminium. However, while HfO_2 doping is essential for the manufacture of high-performance FeRAMs, it introduces other challenges into the other technological steps of fabrication. Doping species are materials that are difficult to remove by plasma etching. This can make plasma etching of the FeRAM stack tricky, leaving residues on the wafer or contaminating the reactor walls, which could compromise the introduction of doped HfO_2 in FeRAM. Today, there is virtually no literature on the plasma etching of doped HfO_2, leaving a vast field of investigation.

Objective :

In this context, the aim of this Master 2 internship project is to develop a plasma etching process for Gadolinium-doped HfO_2. The etching experiments will be carried out in the LTM's 200 mm inductively coupled plasma (ICP) reactor located in CEA/Leti's clean room. The development of the plasma process will be based on a fundamental understanding of the etching mechanisms of $Gd:HfO_2$. To this end, a number of characterization techniques will be used: ellipsometry to determine etch rates as a function of the selected plasma parameters, X-ray spectrometry (XPS) to analyze the physico-chemical modification of the HfO_2 surface exposed to the plasma, and AFM to determine the surface roughness. This work will be carried out in the LTM's PROSPECT team in collaboration with CEA/Leti's etch team.

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- ✓ **Education: M2**
- ✓ **Duration: 6 months**
- ✓ **Start: March 2025**
- ✓ **Salary : 650 euros/month**

APPLY

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