# An Effective Process for Oxygen Defects Suppression for La-based Oxide Gate Dielectric

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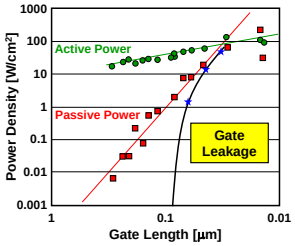
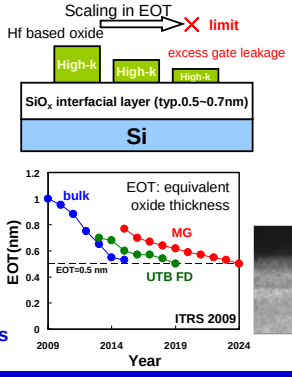
## Motivation & Objective



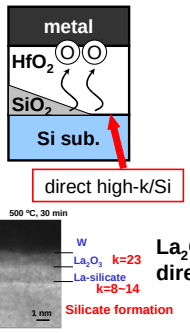

**Power Crisis**

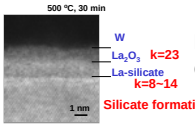
$$EOT = \frac{\varepsilon_{SiO_2}}{\varepsilon_{High-k}} T_{High-k}$$

**EOT : Equivalent Oxide Thickness**

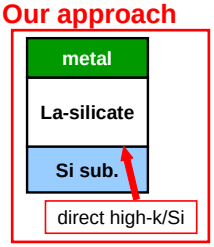



**IL scavenging**

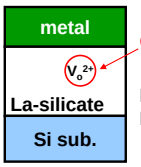



**Our approach**




**Problem**




Oxygen defects

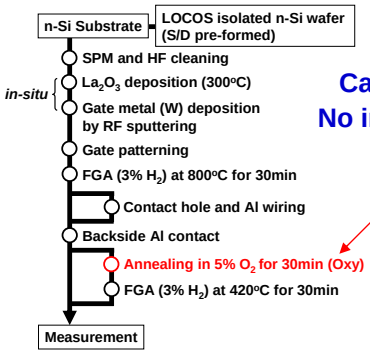
Essential influence on MOSFET characteristics

**How to control oxygen defects ?**

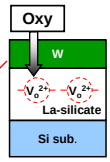
**$La_2O_3$ can easily achieve direct contact of high-k/Si**

**Material & process concept for compensation of oxygen defects are proposed**

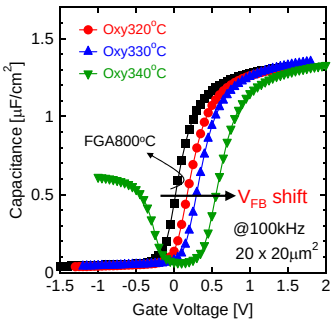
## Experimental Procedure



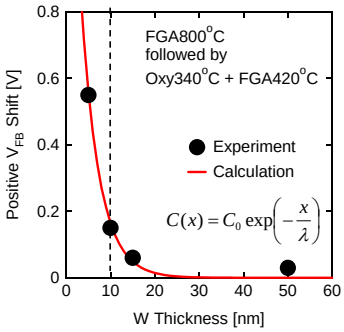

**Careful process**
**No increase in EOT**



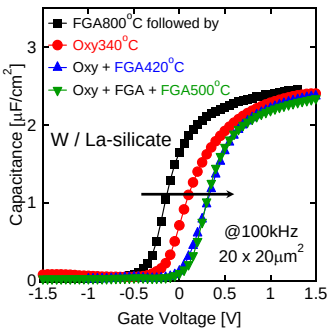

## Experimental Results



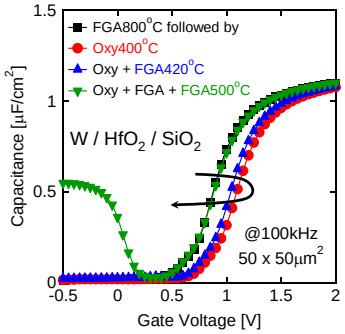

**Positive $V_{FB}$ Shift**
**Turn up in inversion**



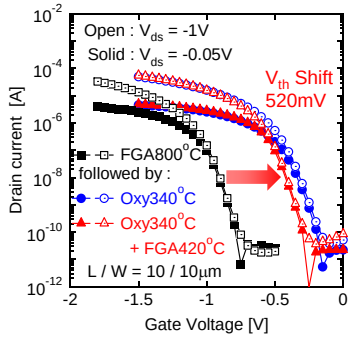

**Oxygen diffuse through the W metal layer**



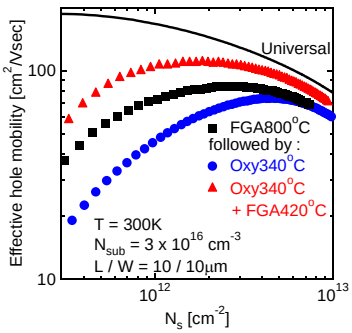

**Oxygen is maintained in La-silicate**



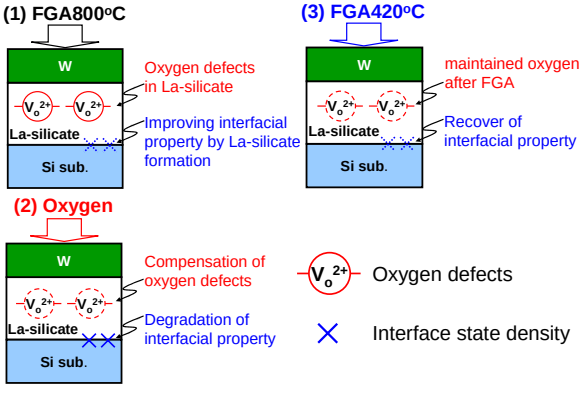

**Oxygen is released from $HfO_2$**

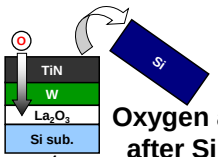



**$V_{th}$ lowered by 520 mV**
**FGA recovers the SS.**

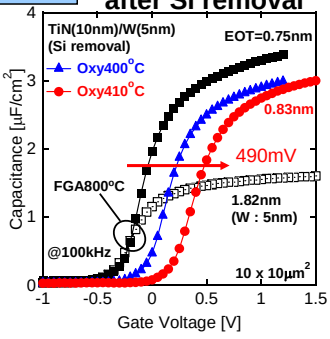



**Mobility improvement**
**Compensation of defects**




**Oxygen annealing after Si removal**




## Conclusions

**Development of oxygen annealing process**

**Improving carrier mobility by defects compensation**

**Demonstration of oxygen annealing after Si removal for scaled EOT**