Chapter 5

Future Work

Less than 3nm gate dielectric with both high drivability and reliability is necessary for realizing high performance CMOS devices. Because nitrogen incorporated oxide can solve these problems, fabrication technology of ultrathin gate dielectrics with high nitrogen concentration is required. Nitridation treatment on ultrathin oxide has been used in MOS technology to strengthen both the dielectrics robustness and electrical stress, meanwhile it also can apply to form high permittivity gate dielectric stacks. Besides, it has its excellent resistance of boron penetration and is a good buffer layer candidate between high-K gate dielectric and Si substrate. There are a number of topics relevant to this thesis, which may deserve further studies. The following topics are suggested for future work:

First of all, Boron penetration suppression is one of the key issues for PMOSFETs with ultrathin gate dielectrics. Based on our novel process, PMOSFETs will be fabricated to further the electrical properties of the PMOSFETs with the oxynitride, such as transconductance and hot carrier effect, etc..

Secondly, according to the current results obtained so far, with such good electrical characteristics and reliability properties of oxynitride, it manifests a high competence for a number of applications to deep submicrometer. Among them are the

following:

(1) Application of the interfacial layer between high-k and substrate:

High-nitrogen oxynitride has both the ability to withstand the penetration of the oxygen atoms and low density of interface state (D_{it}). For certain high-K materials such as HfO_2 and ZrO_2, they suffer the oxygen atom outdiffusion into substrate during deposition. Hence, this problem can be improved if oxynitride film can be inserted in between. That is, we grow the oxynitrde film first before the formation of the HfO_2 and ZrO_2. Then, the HfO_2/oxynitride and ZrO_2/oxynitride films will have a large possibility to optimize these high-K materials.

(2) Application of SONOS button oxide:

For Polysilicon-blocking Oxide-silicon Nitride-tunneling Oxide-Silicon (SONOS), one of the mechanisms to degrade the ability of charge retention is by trap to trap tunneling (TTT), which means that electron stored in nitride trap directly tunnel through the tunnel oxide to silicon substrate via the interface state. By our technique, oxynitride with D_{it} could improve the charge retention of SONOS.