Enhancing Interface and Retention Characteristics in NAND Flash Memory by Increasing Poly-Si Thickness to Prevent Pin-Hole Formation

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In the fabrication of NAND Flash memory cells, the integrity of the tunneling oxide (DTOX) layer plays a critical role in ensuring the reliable operation and longevity of memory devices. This study focuses on the process following channel hole etching, particularly the deposition of the tunneling oxide, and addresses the challenges posed by plasma damage and hydrofluoric acid (HF) damage during subsequent processing steps. These damages can lead to the formation of pin-holes at the DTOX interface, significantly degrading the interface characteristics and compromising data retention capabilities.

To mitigate these issues, we investigate the effects of increasing the thickness of the polysilicon (Poly-Si) layer deposited on the DTOX. By optimizing the Poly-Si thickness, we aim to enhance the barrier against plasma and HF damage, thereby preventing pin-hole formation and improving interface integrity. Our experimental results reveal that a thicker Poly-Si layer provides substantial protection for the DTOX, resulting in improved electrical characteristics and enhanced data retention performance.

Additionally, we analyze the correlation between the Poly-Si thickness and the resulting interface quality through various characterization techniques, including micro-photoluminescence (μ-PL) and high-resolution scanning transmission electron microscopy (HR-STEM). These complementary techniques allow us to gain deeper insights into the mechanisms by which Poly-Si thickness influences the behavior of quantum confined systems within the memory cells.

The findings from this study not only address the pressing challenges in NAND Flash memory fabrication but also underscore the importance of interface engineering in advancing the performance and reliability of memory devices. By implementing optimized deposition strategies, we can pave the way for the development of next-generation NAND Flash technologies.