ナノ三次元シリコン構造体エッジにおける酸化遅延

Oxidation delay at the edge of 3-dimensional (3D) nano-structured silicon

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Understanding and control of oxidation of 3D nano-structured Si is important for the 3-dimensional (3D) nano-structured (gate-all-around- or fin- structured) vertical MOSFET. Till now, many reports focused on a certain type of 3D structures such as nano pillar or nano fin, which limits the deep understanding of Si oxidation. Actually, 3D structure consists of two or more 2D surfaces; it is easy to consider that the oxidation of 3D nano-sized Si is decided by two factors: the contained 2D planar surfaces and the edge situation of 2D surface (most case is the mutual influence between 2D adjacent surfaces). The former one should mostly follow the traditional 2D oxidation theory, because the traditional 2D oxidation theory (such as layer-by-layer oxidation) has already been studied in several nanometers level. But the later one, has less report. In this work, we investigated the oxidation of several 3D nano-structures (pillar, fin, and terrace), we found the oxidation of region near the edge of Si, no matter the edge is an un-oxidized Si_3N_4, or a simultaneously oxidized convex- or concave-structured adjacent 2D planar surface as shown in Figure. 1, is delayed by edge [1]. We defined this phenomenon as “edge effect” and discussed its mechanism. Edge effect can be used to explain the shape difference obtained for similar initial Si nano-structures after oxidation, it could also be used to interpret the self-limiting oxidation (a retarded oxidation phenomenon) in Si nano pillar and some argues occurred in 2D layer-by-layer oxidation.

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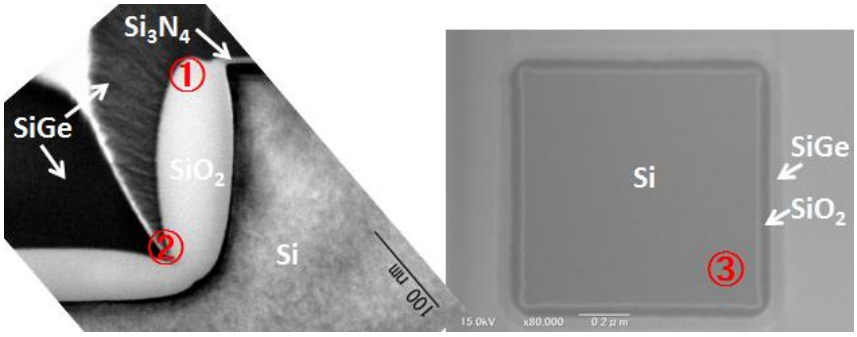

Figure. 1 Oxidation at edge with ①an un-oxidized Si_3N_4, a simultaneously oxidized ② concave- and ③convex- structured adjacent 2D surface.

[1] Shujun Ye, Tetsuo Endoh. Edge effect in oxidation of 3-dimensional (3D) nano-structured silicon. **Submitted**.