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Ordered and Epitaxial Nanophases of Beta-Cristobalite Silicon Dioxide Including Thin and Ultra-thin Films and Interphases on Silicon (100) Substrate and Applications Thereof

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Intellectual Property Status:

Patent pending

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Background

In the manufacture of (Silicon based) semiconductor devices, an oxide layer is typically formed at the surface of a wafer prior to device fabrication. This oxide layer (such as SiO_2 grown on a Si (100) surface) typically grows completely amorphous with little ordering in the first atomic layers near the interface. This can lead to thickness and structural variations that can affect the electronic performance of devices using these oxides.

Invention Description

Researchers at Arizona State University have developed a proprietary method to grow oxide layers in an ordered manner (US6,613,677). Further innovations allow a controlled growth of a new epitaxial phase of SiO_2 that is aligned with the Silicon (100) substrate.

This improved technique enhances the material and electronic properties of semiconductor devices by reducing the level of interfacial defects at the oxide/semiconductor interface. Additionally, this innovation increases layer smoothness, thickness control, and chemical stability, as well as decreasing electronic defect density, and lowering the process temperature. Further heteroepitaxial growth upon the ordered oxide is also enabled.

Potential Applications

- MOSFETs with improved carrier lifetimes
- Low temperature epitaxy on Si for materials including SiGe, SiGeC, SiGeSn, GaAs, high-k dielectrics, peroskovites, silicides and metals
- Improved layers for light sensors, mirrors, light detectors and solar cells – reduced surface recombination
- Deposition of multilayer heteroepitaxial oxide films
- Applicability to other material systems (e.g. III-V)

Benefits and Advantages

- Enhanced reliability and long-term performance of devices
- Several orders of magnitude higher chemical stability and resistance to surface contamination – allowing wider processing window, reduced costs, higher yields
- Enhanced carrier lifetime: 3 times over ordered oxides
- Low defect density at the substrate/oxide interface
- Low temperature process epitaxy