ARIZONA STATE UNIVERSITY

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Long Range Ordered Semiconductor Interface Phase and Oxides

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Invention Description

In the manufacture of semiconductor devices, the substrate, usually Silicon, is oxidized to form an oxide layer at the surface 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.

To overcome this problem, researchers at Arizona State University have developed a method to grow such oxide layers in an ordered manner, to significantly enhance the material and electronic properties of semiconductor devices. Using a newly developed method, up to 80% of an ordered phase is obtained in SiO_2 thin films ranging in thickness from approximately 1.25 to 30 nm grown on Si (100) surfaces. With respect to these thin films, capacitance-voltage measurements on MOS structures indicate a dramatic improvement in flat-band voltages along with a decrease in fixed charge in the oxide, and especially increased carrier lifetime under the oxide. This also lowers the interface state density.

Further enhancements to the process allow one to obtain a higher degree of perfection resulting in improvements to the surface optical properties as well. This process also lends itself to good control of the growth kinetics of the oxide layer thereby opening up the possibility of much improved control over the electrical properties of resultant devices. This process is also useful for improving the oxide surfaces of alternative semiconductor systems such as GaAs and SiGe, which are known to exhibit notoriously high defect densities.

Potential Applications

- Improved carrier lifetimes in MOSFETs
- 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.

Benefits and Advantages

- Low defect density at the substrate/oxide interface.
- Enhanced carrier lifetimes.
- Enhanced reliability and long-term performance of oxide films.
- High chemical stability and resistance to surface contamination – allowing wider processing window.
- Low temperature process epitaxy.
- Improved optical absorption properties.

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