National Aeronautics and
Space Administration

Electrical and Electronics

High Mobility Transport Layer Structures for Rhombohedral Si/Ge/SiGe Devices

Improved carrier mobility for solar cells and other electronic devices

The innovation builds off NASA's IP portfolio for making high-quality crystalline SiGe thin films grown on sapphire substrates. In this case, a distinct layer structure is used to create quantum well structures to provide a very high mobility pathway for both p-type and n-type charge carriers. The primary intended application of this technology is for solar cells where the band gap structure and charge carrier mobility combine to provide the potential for highly efficient solar cells. Furthermore the layer structure enables back-side illumination such that the effective solar cell area for light capture is maximized. Conversion efficiency is expected to be on the order of 30% or greater.

BENEFITS

- Potential for high-efficiency thin film solar cells, 30% conversion efficiency or greater
- Uses conventional thin film processes commonly used in silicon semiconductor processing
- Materials are relatively abundant, low-cost, and non-toxic as compared to other leading thin film solar cell materials
- Backside illumination reduces solar radiation losses from electrical contacts

APPLICATIONS

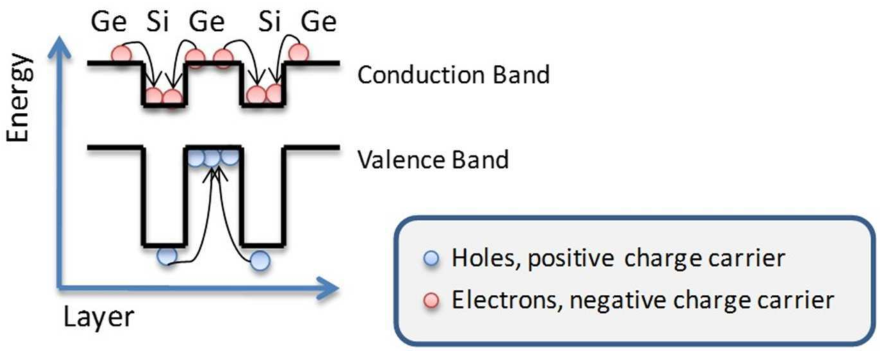
- Solar cells
- Semiconductors
- Thermo-electric devices

technology solution

THE TECHNOLOGY

Performance of solar cells and other electronic devices such as transistors can be improved greatly if carrier mobility is increased. Si and Ge have Type-II bandgap alignment in cubically strained and relaxed layers. Quantum well and super lattice with Si, Ge, and SiGe have been good noble structures to build high electron mobility layer and high hole mobility layers. However, the atomic lattice constant of Ge is bigger than that of Si and direct epitaxial growth generates large density of misfit dislocations which decrease carrier mobility and shorten device life time. So it required special buffer layers such as super lattice or gradient indexed layers to grow Ge on Si wafers or Si on Ge wafers. The growth of these buffer layers takes extra effort and time such as post-annealing process to remove dislocations by dislocation gliding inside buffer layer.

This invention is a fabrication method for high mobility layer structures of rhombohedrally aligned SiGe on a trigonal substrate. The invention utilizes C-plane (0001) Sapphire which has a triangle plane, and a Si (Ge) (C) (111) crystal or an alloy of group TV semiconductor (111) crystal grown on the Sapphire.



Type-II bandgap alignment of Si and Ge

PUBLICATIONS

Patent Pending

More Information

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NP-2015-08-2016-HQ

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LAR-17841-1