Tetradymite Buffer Layer Assisted Heteroepitaxial Growth

Technology #5524

A research team at the University of Michigan has developed a heteroepitaxial growth technique that enables single crystalline growth on low-cost, lattice-mismatched substrates. Optoelectronic devices, including solar cells, light-emitting diodes (LEDs), and lasers, generally require active area growth on expensive, lattice-matched, III-V semiconductor wafers resulting in high manufacturing and product cost. Often, for these applications, the substrate is only required to seed crystalline growth, regardless of its electronic properties; although seeding growth using inexpensive substrates is attractive, it has traditionally been very challenging to achieve high-quality material growth on such substrates. This new growth technique efficiently relaxes lattice-mismatch between substrate and active growth using an engineered buffer layer that has the potential to significantly affect conventional optoelectronics technologies.

Crystalline Growth on Low-cost, Lattice-mismatched Substrates

Using a tunable tetradymite (Bi$_2$Te$_3$) layer, the research team’s buffer layer growth technique has been applied to various substrate materials, including fused quartz (glass), GaP, Ge, InAs, MgO, and spinel, among others. Single crystalline growth transitions with thin, 1-3 nm, amorphous interfacial layers have been achieved and verified with transmission electron microscopy. Growth optimization has produced monolayer crystal growth transitions on Ge and GaP substrates, despite significant lattice-mismatch, eliminating the amorphous transition layer found in conventional epitaxial growth. This growth technique has the potential to lower manufacturing costs and improve heteroepitaxy for a variety of optoelectronic applications.

Applications

- Photovoltaic cells
- LEDs and solid-state lighting
- Thermal detector manufacturing
- Thermoelectrics
- Laser structures

Advantages

- Minimizes defects in lattice-mismatched systems
- Single monolayer growth transitions
- Enables epitaxial deposition onto low-cost growth substrates, including glass

Inventors

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