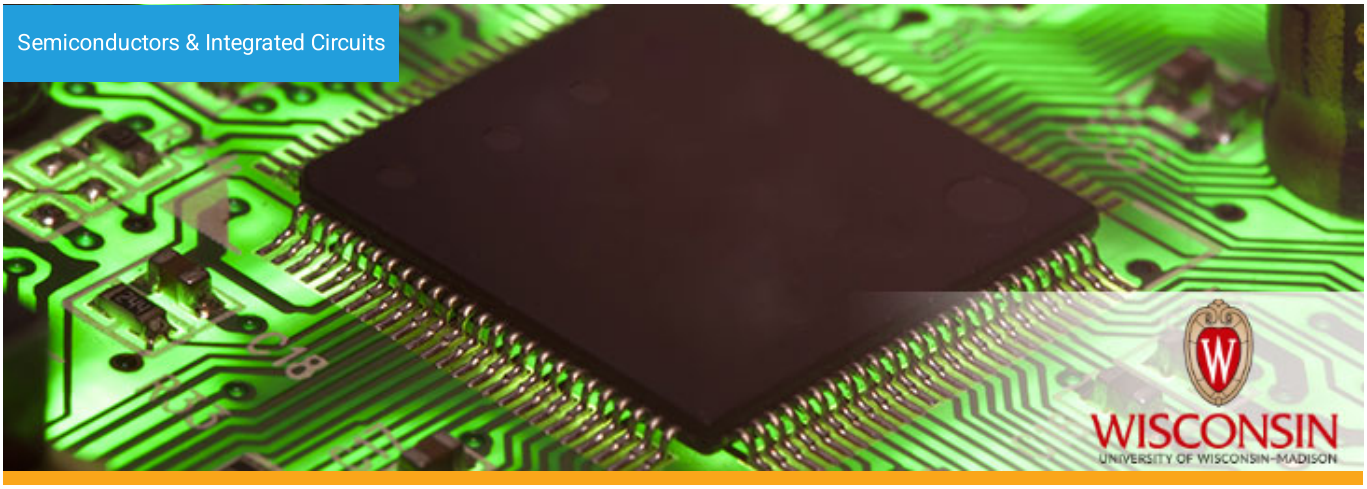

Reusable Virtual Substrates for Growing Semiconductor Devices

View U.S. Patent No. 9,064,774 in PDF format.

WARF: P130206US01

Inventors: Thomas Kuech, Kevin Schulte, Luke Mawst, Tae Wan Kim, Brian Zutter

The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing faster and cheaper methods for making virtual substrates having thick, highly relaxed metamorphic buffer layers.

Overview

'Virtual substrates' comprise an underlying growth substrate and one or more metamorphic buffer layers (MBLs) made of semiconductor alloy. The MBL is graded so that its lattice constant initially matches the underlying growth substrate, but transitions to a second lattice constant at its surface, where a semiconductor device subsequently will be grown.

In this way, the use of MBLs allows a variety of high-quality semiconductor devices (e.g., quantum cascade lasers) to be grown, even though the devices may be lattice-mismatched to the underlying growth substrate. Ideally, MBLs should have the properties of high strain relaxation and low threading dislocation. Unfortunately, achieving both goals at the same time is difficult.

Different epitaxy processes have been used to grow MBLs with varying degrees of success in mitigating threading dislocation. Still, residual strain remains a problem in these structures.

The Invention

UW–Madison researchers have developed improved virtual substrates using hydride vapor phase epitaxy (HVPE). HVPE is a well-known technique that enables thick layers of semiconductor to be grown in short periods of time.

The virtual substrates comprise several layers. The underlying GaAs substrate has a certain lattice constant. Over this, an MBL is grown via the HVPE process. The MBL is sufficiently thick to avoid warping. It is compositionally graded so that its lattice constant matches the underlying substrate, but transitions to a different lattice constant at its surface where the semiconductor device will be grown.

The MBL surface can be polished and reused to grow multiple semiconductor devices.

Applications

- High-speed transistors
- Optical electronics, photodetectors and photodiodes
- Transparent substrates for light-emitting diodes (LEDs) and lasers
- Solar energy technologies

Key Benefits

- HVPE is faster and cheaper than other epitaxial growth methods.
- Thicker layers maximize strain relief and minimize threading dislocation.

- Avoids warping
- Higher growth temperatures reduce work-hardening effects.

Additional Information

For More Information About the Inventors

- Thomas Kuech
- Luke Mawst

Related Technologies

- WARF reference number P110156US01 describes a method for growing a quantum cascade laser on metamorphic buffer layers to achieve shorter emission wavelength and increased continuous wave efficiency.

Tech Fields

- Semiconductors & Integrated Circuits : Components & materials

For current licensing status, please contact Michael Carey at mcarey@warf.org or 608-960-9867