Eliminating Phase Separation Issues

A technique to grow group-III nitride alloys

Georgia Tech researchers have developed an innovative technique to grow group-III nitride alloys, including AlN, InN, GaN, InGaN, and AlInGaN. Their method employs metal-rich molecular-beam epitaxy (MBE) while successfully avoiding thermal and spinodal decomposition. It also maintains a metal adlayer thickness that reduces the probability of indium surface segregation. The technique produces alloy growth at higher rates and at lower processing temperatures (~250–850 °C) than with other MBE processes. It achieves this by periodically modulating the metal flux while maintaining a constant nitrogen flux, a process that can be called metal-modulated epitaxy (MME). This technique minimizes metallic droplets forming on the surface while still taking advantage of enhanced adlayer mobility provided by excess metal. The lower growth temperatures enable the growth of four-element alloys. The method also can involve the use of a reflection of high-energy electron diffraction apparatus, providing an in situ analysis of metal adlayer thickness, surface smoothness, and growth rates.

Summary Bullets

- Phase separation is eliminated
- Growth process is faster
- Processing temperatures are lower and over a wider range

Solution Advantages

- Phase separation is eliminated
- Growth process is faster
- Processing temperatures are lower and over a wider range
- Crystal quality is increased
- Grain sizes are increased

Potential Commercial Applications

- LEDs
- Photovoltaics
- Wireless infrastructure
- High-power electronics (e.g., for electric cars)
- Consumer electronics

- Telecommunications
- Aerospace
- Nanoscale electronics
- Optoelectronics
- Biochemical sensing

Background and More Information

Currently, no native substrate currently exists for all group-III nitride growth, due to differences in the lattice spacings between the AlN, GaN, and InN binaries. Although some of the effects of this mismatch can be mitigated with prepared templates, this approach cannot be used for light emitting diodes (LEDs) with low wavelength emissions nor for solar cells, laser diodes, and other complex structures. Conventional processes to address this issue have been unsuccessful, mostly resulting in phase separation via thermal decomposition, spinodal decomposition, or indium surface segregation. A new technique was needed to solve the phase-separation problem.

Inventors

- Michael Moseley
  Graduate Research Assistant at Georgia Institute of Technology
- Dr. William Doolittle
  Professor and Director of Advanced Semiconductor Technology Facility (ASTF) - Georgia Tech School of Electrical and Computer

IP Status

<p>Patent has issued</p>: US9142413

Publications

, -

Images

Visit the Technology here:
[Eliminating Phase Separation Issues]
