1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

Case ID:M01-062P^
Published: 2/26/2020

Low Temperature Epitaxial Growth of Quaternary Wide Bandgap Semiconductors

Inventors

John Kouvetakis
Ignatius Tsong
Radek Roucka
John Tolle

Contact

Shen Yan
shen.yan@skysonginnovations.com

The advent of epitaxial techniques for growing thin films has allowed for the growth of unnatural, metastable structures having properties previously unattainable in equilibrium systems. Specifically, quaternary compounds are of great interest for microelectronic and optoelectronic devices due to expectations that these materials will exhibit the promising physical (e.g. mechanical hardness, thermal expansion, close matching lattice parameters, etc.) and electronic properties of their binary constituents. Indeed, quaternary materials may not only have bandgaps intermediate to those of the constituent binary systems, but in some cases, may even have direct bandgaps. Existing high temperature synthetic methods, although of research importance, are not suitable for commercial production of SiCAlN or other quaternary thin films comprising Group IV and Group III elements.

Researchers at Arizona State University have developed a method for depositing an epitaxial thin film having the quaternary formula YCZN wherein Y is a Group IV element and Z is a Group III element on a substrate at temperature between ambient and 1000°C in a gas source molecular beam epitaxial (GSMBE) chamber. This method provides high purity, low defect, device quality quaternary epitaxial thin films, such as SiCAlN, for deposition on silicon and silicon carbide substrates. These films demonstrate bandgaps ranging from 2 eV to 6 eV with a spectral range from visible to ultraviolet. Also, the quaternary compounds may function as a superhard coating material.

Potential Applications

- Microelectronics
- Optoelectronics

Benefits and Advantages

- Provides a Means for Commercial Quaternary Thin Film Production ? allows for fabrication of high purity, low defect, device quality quaternary epitaxial thin flims (e.g. SiCAlN, GeCAlN, etc.)
  - Demonstrates Positive Physical Properties (e.g. mechanical hardness, thermal expansion, close matching lattice parameters, etc.) ? functional as a superhard coating material
  - Demonstrates Positive Electronic Properties (e.g. intermediate range bandgap compared to binary constituents, potential for direct bandgaps, etc.) ? bandgaps range from 2 eV ? 6 eV; spectral range from visible to ultraviolet
- Operates in Substantially Improved Temperature Range (Ambient - 1000°C) ? alternative approaches require temperatures as high as 2100°C