Sandia National Laboratories

Electrochemical Solution Growth

POTENTIAL MARKET APPLICATIONS

LEDS-general illumination, backlighting, displays, and automotive

Lasers (ultraviolet through green wavelengths)-homeland security and military, illumination, and data storage

Vehicle Electrification

Down-hole drilling diagnostics-future market

Utility grid modernization (incorporation of renewable energy using energy storage)

BENEFITS

High potential for producing superior-quality, economical bulk GAN substrates

Helps fully realize GAN's true potential

Less expensive than alternate approaches

TECHNOLOGY READINESS LEVEL

Sandia estimates this technology at approximately TRL 5. Key elements demonstrated in relevant environments.

INTELLECTUAL PROPERTY

US PATENT #7,435,297

HTTPS://IP.SANDIA.GOV

TECHNOLOGY SUMMARY

Sandia National Laboratories has developed a disruptive new crystal growth technology, called Electrochemical Solution Growth (ESG). This technology has a high potential for producing the high-quality, large-area, and economical bulk gallium nitride (GaN) substrates needed to meet the performance requirements of high-efficiency LED and high-power transistors. Substrates are the bulk wafer material on which opto/electronic think film devices are fabricated; they dictate the crystalline quality and thus the performance of these devices. GaN substrates, which currently do not exist, are necessary for these devices to reach their full market potential.

ESG represents a revolution in crystal growth technology that borrows well-developed concepts from Rotating Disk Reactor metalorganic chemical vapor deposition (MOCVD) technology. The ions are delivered to a rotating seed crystal surface by way of the fluid dynamics imposed by the rotating seed and/ or susceptor. The ions then diffuse across a fluid boundary layer near the surface of the seed, where they react and deposit to form single crystal GaN. The nitride and gallium ionic precursors can be controlled reliably and precisely using common electrochemical techniques programmed through the potentiostat. Because the growth condition remain steady-state throughout the process, a single crystal boule may be pulled from the surface. The reactor design is fully laterally scalable, and the vertical direction can be grown as long as the supply of gallium and nitrogen gas allow. The growth rate is high for high throughput, and the technology is low cost. Wafers may be sliced out of the boule from any direction to produce substrates of any desired orientation.

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NNSA National Nuclear Security Administration

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SAND # 2011-6933P