

GaN 2007

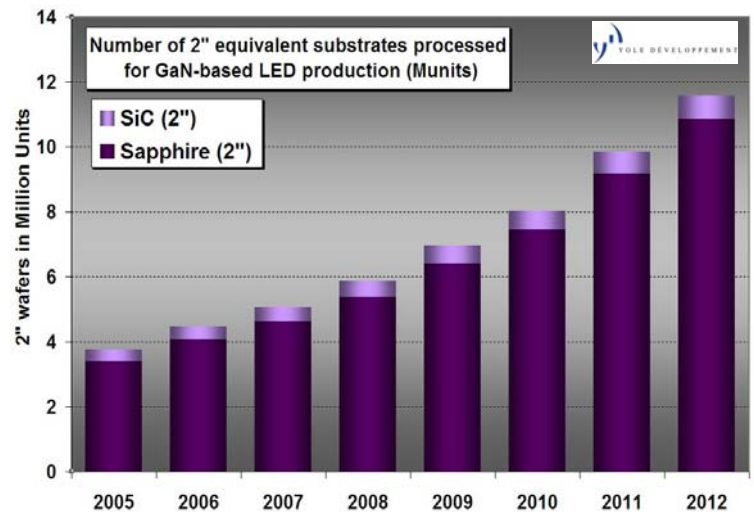
New perspectives for nitride materials and devices

UNIQUE REPORT DESCRIBING GALLIUM NITRIDE SUBSTRATES & DEVICES TECHNOLOGIES AND MARKETS

With an annual volume of more than 5 millions units of 2" equivalent substrates, GaN-based green, blue and white LED is the main eater of nitride materials targeting a \$3.5B market at devices level. Current split shows that SiC substrates is accounting for ~10% of the total production, sapphire making the balancing.

Sapphire market for LED is now tending toward equilibrium with 2/3 LED manufactured on 2" and 1/3 on 3" substrates and a recent introduction of 4" production announced by Japanese Showa Denko. Sapphire material market has then just beaten the \$150M barrier in 2006.

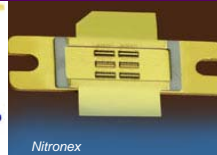
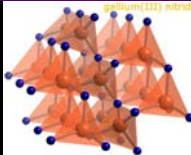
SiC is also entering in a 4" production stage at CREE but cannot be considered as a real open market.



This report highlights the following topics:

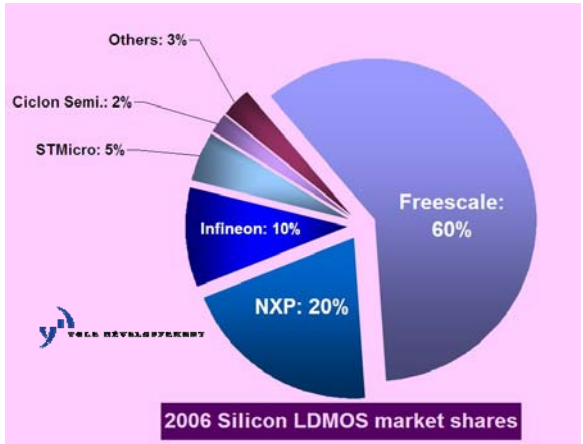
- Detailed current market playground and expected evolutions for the following devices:
 - GaN-based HB-LED and related applications
 - Blue laser diodes and high density data storage business
 - Power electronics accessible to GaN FET and Schottky diodes
 - High power RF electronics and related PA market in various fields
 - Technical analysis of GaN devices in use in the related applications
- Complete description of new emerging substrates for GaN growth and technologies under investigation
- Devices cost analysis comparing current substrates with emerging ones
- Quantification of market opportunities in volumes and revenues for GaN substrates



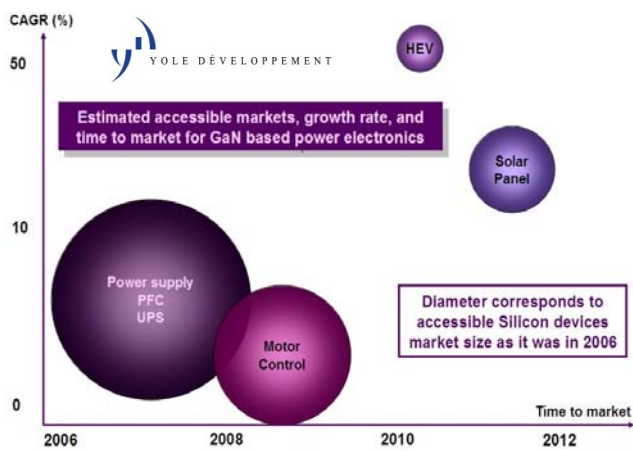


"AS LONG AS HOMO-EPITAXY OF GALLIUM NITRIDE ON BULK GALLIUM NITRIDE WON'T BE COST EFFECTIVE AND AVAILABLE IN LARGE DIAMETERS, SCIENTISTS WILL PUSH ALTERNATIVE SUBSTRATES AT THEIR LIMITS..."

The substrate market playground can be seen as partially unstable because of the rapid emergence of new substrates for GaN epitaxy. GaN-on-Silicon, GaN-on-ZnO, GaN-on-Germanium, GaN-on-Glass, GaN-on-AlN and composite substrates like GaN-on-diamond or Picogiga GaN-on-SopSiC are now pursuing the same Rubicon: propose the best compromise between GaN quality, large diameter, low bowing, high Tc, controlled TCE and of course, low cost. 6" is the main target and is now available of-the-shelf from selected companies. That is opening new doors to higher LED productivity toward the gigantic SSL general illumination business.



In the RF business, GaN HEMT is now ready to challenge Si LDMOS and GaAs pHEMT in the telecommunication base stations market (3G, 4G, WiMAX...). With devices reaching $Psat=174W$ @ 6GHz under 48V polarisation, the GaN technology can be partially implemented among the 2 millions deployed mobile phone base stations and coming next WiMAX infrastructures. A 10,000 x 4" epiwafers market is forecasted in a very near future.



Gallium Nitride (GaN), as silicon carbide (SiC), is a wide bandgap material allowing reaching high breakdown voltage. Thus road to power electronics applications is wide open. However, GaN growth is based on an ethero epitaxy process with often an AlN nucleation layer forcing the devices to be designed laterally. Lateral

devices are limited in term of breakdown voltage compared to vertical ones and become rapidly bulky for high power density ranges. This situation deals with a subtle balance between substrate diameter, power density, chip size and device cost. In other terms, GaN power devices on sapphire, silicon or composite substrates can compete with SiC from a cost point of view using larger substrates (4") to compensate the bigger chip size at a given power density.

Bio



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He is working at Yole Développement since 1998 and is leading the Compound Semiconductors techno-economical market analysis department. He is 37 years old.

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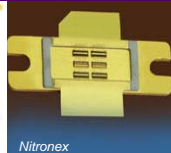
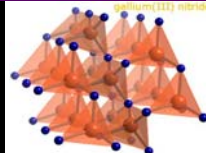


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