ACTUAL APPLICATION WITH COVER SHEET FOR GLOBAL VENTURE CHALLENGE 2009

SiMetal

Purdue University

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Novel Fabrication Method for GaN-on-Silicon LED Chips

What is your product? Our product is GaN-on-Silicon LED chips, using a novel fabrication method, which will reduce the cost of LED chips by 80% through reduced material, equipment, and production cost. The novel process will also increase reliability of LED chips.

What is the underlying technology and what does it do? We have developed a method to eliminate the detrimental characteristics of silicon by "metalizing" the silicon substrate with a built-in back-contact/reflective layer of zirconium nitride. The presence of a reflective layer will recover light that is directed towards substrate and would normally be lost. This process enables the usage of silicon substrates for LED chips, which in turn will make affordable LEDs for high brightness LED fixtures.

How is the technology unique? LED chip fabrication processes are extremely valuable in an extremely litigious space. As sapphire and SiC LED chips have dominated the market, GaN-on-Silicon LED chips are the next step. The development of a novel process using silicon is the next critical step to achieving cost reductions for the wide-scale adoption of LED lighting. We solve the problem of high cost fabrication of LED chips through a method that uses silicon wafers, rather than sapphire or SiC.

How is the product innovative? With our novel process, fabrication of LED chips on 12" wafers of silicon will scale up and improve reliability. Scalability to this degree is not possible using smaller 6" sapphire wafers, nor feasible with SiC which is very expensive. Additionally, critical to the manufacturability of chips are two processes; lift off and dicing. Both processes are simplified with our technology, further reducing costs. Our process also requires less gallium nitride (<1 μm) to achieve smooth, thin films than what is generally required with a sapphire wafer (~5 μm), further decreasing input costs and process time. The larger wafer size, requiring fewer wafers for product generation, coupled with process improvements and less GaN yield significant cost reductions.

Who will buy it? These GaN-on-Silicon chips will be sold directly to packaging LED companies. They will be offered superior chips, at lower cost and higher reliability than they currently produce. The largest companies producing packaged LEDs create their own chips; however, they will be attracted to our offerings. With our low cost and quality performance, we will offer a product that can assist packaging LED companies to be true competitors in the packaging LED market.

Why will they buy it? The industry players are all concerned about LED chip cost. Cost is linked to materials and production; the LED market cannot expand until LED chip cost is reduced. The high brightness LED space is waiting for advanced methods which will reduce manufacturing costs. Today, with sapphire, manufacturers can produce chips on 6" wafers. By converting to silicon, they will be able to produce on 12" wafers, allowing them to scale up their production. In addition, the infrastructure for silicon processing is already established. We anticipate the cost reduction to be above 80%.

What is the size of the market? In 2006, the LED chip market was an estimated $205MM. By 2011, the LED chip market is expected to increase to $985MM. Of this $205M in 2006 revenues, approximately $100MM to $150MM was sapphire-based LED chips. Most of the remaining $50M was silicon carbide-based LED chips.

How will you protect your intellectual property? The University has a patent application pending with international options on the fabrication method. Furthermore, a cross-platform IP strategy will be employed through continued optimization of this method. Future patentable research will include eliminating the "green gap", which refers to the current inability to fabricate efficient green LEDs.