Voiding defects: New technique makes LED lighting more efficient

January 25 2011

Light-emitting diodes (LEDs) are an increasingly popular technology for use in energy-efficient lighting. Researchers from North Carolina State University have now developed a new technique that reduces defects in the gallium nitride (GaN) films used to create LEDs, making them more efficient.

LED lighting relies on GaN thin films to create the diode structure that produces light. The new technique reduces the number of defects in those films by two to three orders of magnitude. "This improves the quality of the material that emits light," says Dr. Salah Bedair, a professor of electrical and computer engineering at NC State and co-author, with NC State materials science professor Nadia El-Masry, of a paper describing the research. "So, for a given input of electrical power, the output of light can be increased by a factor of two – which is very big." This is particularly true for low electrical power input and for LEDs emitting in the ultraviolet range.

The researchers started with a GaN film that was two microns, or two millionths of a meter, thick and embedded half of that thickness with large voids – empty spaces that were one to two microns long and 0.25 microns in diameter. The researchers found that defects in the film were drawn to the voids and became trapped – leaving the portions of the film above the voids with far fewer defects.

Defects are slight dislocations in the crystalline structure of the GaN films. These dislocations run through the material until they reach the

surface. By placing voids in the film, the researchers effectively placed a "surface" in the middle of the material, preventing the defects from traveling through the rest of the film.

The voids make an impressive difference.

"Without voids, the GaN films have approximately 1010 defects per square centimeter," Bedair says. "With the voids, they have 107 defects. This technique would add an extra step to the manufacturing process for LEDs, but it would result in higher quality, more efficient LEDs."

More information: The paper, "Embedded voids approach for low defect density in epitaxial GaN films," was published online Jan. 17 by *Applied Physics Letters*.

Provided by North Carolina State University