ZnO Nanowire Arrays for Blue LEDs (#5114)

Offers the potential to drive cost out of the LED manufacturing process

Zhong Lin Wang and Sheng Xu from the School of Materials Science and Engineering at Georgia Tech have developed a fabrication process that allows the positioning of ZnO nanowires on GaN thin film using electron beam lithography to position the wire and hydrothermal decomposition to grow the nanowire. To position the wires, the GaN substrate is cleaned and coated with a 50 nm thick layer of polymethyl methacrylate (PMMA). After baking, a thin organic resist is applied and an array of dots etched into the substrate using an electron beam with an area dose of between 500 and 1000 μC/cm². Rinsing follows. The etched array acts to seed hydrothermal growth of ZnO nanowires. The patterned substrate is floated upside down on a nutrient solution of zinc nitrate and hexamethylenetetramine (HMTA) and heated. Following growth, the substrate is cooled and dried. Supercritical drying minimizes collapse of nanowires onto the substrate. To bias the LEDs, PMMA is spin coated on the substrate both to support the nanowires and to insulate the top and bottom electrodes. Plasma etching exposes the nanowire tips, and Ti and Au layers are sputter coated onto the surface to create the top electrode. Electron beam evaporation forms a bottom electrode in the p-GaN substrate. Biasing the p-n junction with about 10V DC generates a blue light luminescence.

Benefits/Advantages

- The process enables uniform positioning of ZnO nanowires on a GaN substrate.
- Etching resist from the substrate using electron beam lithography allows the growth of ZnO nanowires in an array predefined locations.
- The etched substrate is floated etched surface down on a nutrient solution to grow the ZnO nanowire array.
- Substituting ZnO nanowires for n-GaN in blue LEDs will lower the cost of LED light production.

Potential Commercial Applications

LEDs have already been broadly accepted a wide range of applications in lighting the home, automobiles, malls, factories, and the streets. This technology offers the potential to drive cost out of the LED manufacturing process.

Background/Context for This Invention

High power blue LEDs grown on GaN substrates have enabled a global multi-billion dollar market in high efficiency LED white lights. Because ZnO is both cheap to produce and a good light emitter, using ZnO nanowires as the p-type material in the LED should allow cheaper LED manufacturing. Current ZnO deposition techniques produce uneven distributions of ZnO nanowires across the substrate which diminishes light quality.
Dr. Zhong Lin Wang  Sheng Xu
Hightower Chair, Regents’ Professor - Georgia Tech
School of Materials Science and Engineering;
Distinguished Professor - Georgia Tech College of
Engineering
For more information about this technology, please visit:
https://industry.gatech.edu/technology/zno-nanowire-arrays-blue- leds