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Future of nanotech materials with electrical industrial products

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The key challenge faced by electrical industrial systems is how to improve operation efficiency with acceptable cost. The wide possibilities of the existing polymers and, particularly, the huge scenarios of new polymer compounds in electrical technology inspire the researchers of the field to innovate and compound new electrical industrial materials to study their properties and behavior thoroughly. The research work on novel nanotechnology materials is of great significance both nationally and internationally in the field of power engineering, and environmental technology due to the increasing demands of more cost-effective, efficient, reliable and environmentally satisfactory industrial equipment. Recently, preliminary work investigates the capability of nano-composite polymeric materials for electrical insulation to show improved electrical performances with respect to the corresponding conventional materials, possibly filled by nano-grains or chemical additives. For our future view, innovating models of solar cells, power cables, capacitors, and electromagnetic industrial applications, etc., lead to achieve more cost-effective, energy-effective and hence environmentally better electrical technology products. In our research, nanotechnology aims to the following points: 1) Designing theoretical and experimental new life models for developing the electrical materials with micro- and nano-scale fillers for solving its affecting problems, 2) Introducing innovative product models of nanotech solar cells, power cables, capacitors, and electromagnetic industrial applications, etc., based on nanotechnology techniques, 3) Transferring and applying technological cooperation areas of nanotech material engineering, 4) Enhancing the performance of conventional electrical products, 5) Improving the reliability performance based on novel materials of power cables and capacitor products, 6) Enhancing electrical behavior based on the novel composite structure of power cables and capacitors material products theoretically and experimentally, 7) Controlling electrical material properties and the characteristics of dielectric materials with respect to our request and the technology applications usage, 8) Testing new fast possible ways for developing the solar cells properties of nanotech materials via addition nanoparticles, and 9) Investigating different factors affecting the properties of electrical materials.

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Wide bandgap III-nitride nano-hetero structures for new generation of optoelectronic devices

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Nanostructures based on wide bandgap III-nitrides have recently emerged as one of the most promising class of material for site-controlled opto-electronic and nanophotonics devices. But growing high quality thick III-nitride alloys like InGaN, BGaN and AlGaN is challenging due to lattice mismatch induced phase separation, defects and dislocations. Nanoselective area growth (NSAG) of GaN, InGaN and BGaN nanopyramids on GaN template, Si substrates and sacrificial-ZnO/Al2O3 was investigated to mitigate the above issues. Nanopatterned SiO2 with 100 nm circular openings was made using E-beam lithography. Growth of thick InGaN and BGaN was carried out by MOCVD on silicon substrates and ZnO templates. This nano bottom-up approach leads to dislocation free nanostructures due to the three dimensional stress relief mechanisms. In stark contrast to the conventional epilayers, which contain 3D surfaces, huge density of defects and V-pits network, the GaN, InGaN and BGaN nanopyramids are uniformly sized and hexagonal in shape. Cross sectional STEM analysis confirms that these nanopyramids are single crystalline and free from threading dislocations. Full PIN structures were grown sandwiching the InGaN nanopyramids on GaN templates. Further 2D layered BN on 2” sapphire wafers were realized for the first time to serve as a platform for combining graphene nanoelectronics with III-nitride nanophotonic components. Given their expected high performances and lifetime, along with their industrial maturity for light-emitting diode (LEDs) applications, such alloy nanostructures are appealing for new generation of optoelectronc devices. New designs and device structures for high efficiency solar cells, μ-LEDs, gas and water sensors will be presented.

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