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Review

III-Nitride nanowire optoelectronics

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Abstract

Group-III nitride nanowire structures, including GaN, InN, AlN and their alloys, have been intensively studied in the past decade. Unique to this material system is that its energy bandgap can be tuned from the deep ultraviolet (∼6.2 eV for AlN) to the near infrared (∼0.65 eV for InN). In this article, we provide an overview on the recent progress made in III-nitride nanowire optoelectronic devices, including light emitting diodes, lasers, photodetectors, single photon sources, intraband devices, solar cells, and artificial photosynthesis. The present challenges and future prospects of III-nitride nanowire optoelectronic devices are also discussed.

Keywords: GaN; AlN; InN; Nanowire; Optoelectronics; LED; Laser; Solar cell; Photodetector; Solar fuel; Water splitting; Solar hydrogen; Photosynthesis; Si photonics

Contents

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1. Introduction

The first synthesis of gallium-nitride (GaN) was realized by Maruska and Tietjen at Radio Corporation of America Laboratories (Princeton, New Jersey, USA) using a hydride vapor-phase epitaxy process on sapphire substrate in 1969 [1]. Since then, tremendous efforts have been devoted to developing GaN-based optoelectronic and electronic devices. In 2014, the Nobel Prize in Physics was awarded to Profs. Isamu Akasaki, Hiroshi Amano, and Shuji Nakamura for their invention of GaN-based blue light emitting diodes (LEDs), which enabled efficient while light sources [2–4]. Today, GaN-based materials have been widely used in LED lighting, radio-frequency (RF) electronics, power electronics, and many others. For these reasons, III-nitride