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Optical and electrical properties of AlN/AlGa(In)N short period superlattices grown by molecular beam epitaxy

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Abstract

AlN/AlGa(In)N short period superlattices (SPSLs) consisting of 3-6 monolayer (ML) thick barriers of AlN and 2-3 ML thick wells of $Al_xGa_{1-x}(In)N$ have unique optical and electrical properties. The effective energy gap between 4.5 eV (276 nm) and 5.3 eV (234 nm) of these SPSLs depends on the well/barrier thickness ratio, the well composition, and the SPSL period. For example, by varying the AlN barrier thickness while maintaining constant $Al_{0.08}Ga_{0.92}N$ well thickness (2 or 3 MLs) a shift 100 ± 20 meV/ML can be obtained. Increasing the well thickness by one ML and leaving the barrier thickness constant results in a bandgap change of 270 ± 20 meV. Changing the well thickness with fixed SPSL period provides the coarse bandgap change of 400 ± 30 meV. The SPSLs containing over 300 well-barrier pairs with excellent structural properties can be reproducibly grown on sapphire and silicon substrates by molecular beam epitaxy (MBE). We compare the results obtained using ammonia and plasma assisted MBE. Room temperature hole concentration of 1×10^{18} cm^{-3} was obtained in p-type Mg doped SPSLs with an average AlN content up to 70%. In Si doped SPSLs, electron concentration of 3×10^{19} cm^{-3} and room temperature mobility of 10-20 cm^2/Vs were reached. Electrical contacts formed to the wide bandgap p- and n- type SPSLs are found to have low specific contact resistance and to show weak temperature dependence. The SPSLs based LEDs and photodetectors operating in the range of 240 to 290 nm will be discussed.

Biography

Sergey Nikishin received his PhD from Politechnical Institute, St. Petersburg, Russia. In the same city, he was with GIRICOND (1975 – 1979); Ioffe Physical-Technical Institute (1979 – 1995). He was with Colorado State University (1995 – 1997). Since 1997 he is with ECE Department and Nano Tech Center at Texas Tech University. Research interest is in optoelectronic devices. He has coauthored 18 patents and more than 160 papers cited more than 1500 times. He received the scientific USSR Leninski Komsomol's prize (1985), the honorary title "The Inventor of USSR" (1987), the TTU COE Outstanding Research Award (2007). He is IEEE Senior member.