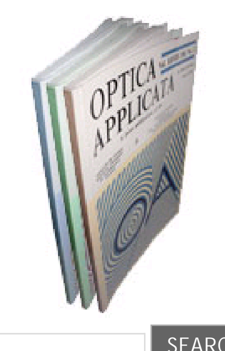

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Piezoelectric effect and spontaneous polarization in computer modelling of A^{III}-N heterostructures

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Keywords

A^{III}-N, computer modelling, heterostructure, 2-dimensional electron gas (2DEG), strain, piezoelectric effect, spontaneous polarization, heterostructure field effect transistor (HFET)

Abstract

The Ga, Al and In nitrides (A^{III}-N) are complete material system suitable in high power and high temperature electronic devices such as $Al_xGa_{1-x}N$/GaN heterostructure field effect transistor (HFET). The examples of computer modelling of A^{III}-N heterostructures were shown. A^{III}-N materials exhibit strong piezoelectric and spontaneous polarization. The computer modelling results showing the influence of layer polarity on carrier distribution in $Al_xGa_{1-x}N$/GaN heterostructure were shown. Only in Ga-faced heterostructures 2-dimensional electron gas (2DEG) is formed. The effect of $Al_xGa_{1-x}N$ layer relaxation on 2DEG concentration in $Al_xGa_{1-x}N$/GaN heterostructure was examined. The difference in spontaneous polarization in $Al_xGa_{1-x}N$ and GaN caused high 2DEG concentration even in $Al_xGa_{1-x}N$/GaN heterostructures with relaxed $Al_xGa_{1-x}N$ layer. Polarization field in $Al_xGa_{1-x}N$ layer in $Al_xGa_{1-x}N$/GaN heterostructure was enough for achieving high 2DEG concentrations in undoped heterostructure. Strained $Al_xGa_{1-x}N$ layer was introduced into typical HFET heterostructure. GaN layer above an interlayer was depleted and the negative influence of using non semi-insulating GaN layer in HFET transistor was reduced.

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