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Modeling of polarization effects on n-GaN/i-InGaN/p-Gan solar cells with ultrathin GaN interlayers

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Abstract We report the numerical study of n-GaN/i-InGaN/p-GaN solar cells on Ga-face substrates with thin GaN interlayers present in the intrinsic InGaN region. These interlayers have recently been shown to significantly increase the crystal quality of thick InGaN layers (>120 nm). We find that tunneling is efficient in n-i-p structures having interlayers ≤ 1.5 nm thick if polarization charges are sufficiently screened. If left unscreened, the large polarization charges naturally formed at the heterointerfaces degrades n-i-p performance, at a given interlayer thickness, because polarization charges increase the distance that carriers must tunnel. Simulations identify favorable parameter ranges.

Keywords Solar Cell · InGaN · Polarization · n-i-p

1 Introduction

The $In_xGa_{1-x}N$ system has been researched extensively for photovoltaic use after the bandgap of InN was discovered to be 0.64 eV (Wu et al. 2003). This system has several attractive qualities. It has a direct bandgap over the entire compositional range, possesses high carrier mobility and drift velocity, is highly resistant to radiation damage, and exhibits high optical absorption ($>10^5$ cm^{-1}) near the bandgap. Unfortunately growing thick InGaN layers (>100 nm), at high indium concentrations, has proven difficult because of indium segregation effects (Faleev et al. 2008; Gorczyca et al. 2009; Pantzas et al. 2012). These transition effects can quickly degrade device performance to unacceptable levels. Several groups have made significant advances despite these challenges. Both molecular beam epitaxy (MBE)

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