

## 2106 kA/cm<sup>2</sup> Peak Tunneling Current Density in GaN-Based Resonant Tunneling Diode with an Intrinsic Oscillation Frequency of ~260GHz at Room Temperature

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**Abstract :** Terahertz spectra is in great demand since last two decades for many photonic and electronic applications. III-Nitride resonant tunneling diode is one of the promising candidates for portable and compact THz sources. Room temperature microwave oscillator based on GaN/AlN resonant tunneling diode was reported in this work. The devices, grown by plasma-assisted molecular-beam epitaxy on free-standing c-plane GaN substrates, exhibit highly repeatable and robust negative differential resistance (NDR) characteristics at room temperature. To improve the interface quality at the active region in RTD, indium surfactant assisted growth is adopted to enhance the surface mobility of metal atoms on growing film front. Thanks to the lowered valley current associated with the suppression of threading dislocation scattering on low dislocation GaN substrate, a positive peak current density of record-high 2.1 MA/cm<sup>2</sup> in conjunction with a peak-to-valley current ratio (PVCR) of 1.2 are obtained, which is the best results reported in nitride-based RTDs up to now considering the peak current density and PVCR values simultaneously. When biased within the NDR region, microwave oscillations are measured with a fundamental frequency of 0.31 GHz, yielding an output power of 5.37  $\mu$ W. Impedance mismatch results in the limited output power and oscillation frequency described above. The actual measured intrinsic capacitance is only 30fF. Using a small-signal equivalent circuit model, the maximum intrinsic frequency of oscillation for these diodes is estimated to be ~260GHz. This work demonstrates a microwave oscillator based on resonant tunneling effect, which can meet the demands of terahertz spectral devices, more importantly providing guidance for the fabrication of the complex nitride terahertz and quantum effect devices.

**Keywords :** GaN resonant tunneling diode, peak current density, microwave oscillation, intrinsic capacitance

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