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Accession number:20114514500236

Title:Engineering the current-voltage characteristics of metal-insulator-metal diodes using double-insulator tunnel barriers

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Source title:Solid-State Electronics
Abbreviated source title:Solid-State Electron.
Volume:67
Issue:1
Issue date:January 2012
Publication year:2012
Pages:94-99
Language:English
ISSN:00381101
CODEN:SSELA5
Document type:Journal article (JA)
Publisher:Elsevier Ltd, Langford Lane, Kidlington, Oxford, OX5 1GB, United Kingdom

Abstract:The femtosecond-fast transport in metal-insulator-metal (MIM) tunnel diodes makes them attractive for applications such as ultra-high frequency rectenna detectors and solar cells, and mixers. These applications impose severe requirements on the diode current-voltage I(V) characteristics. For example, rectennas operating at terahertz or higher frequencies require diodes to have low resistance and adequate nonlinearity. To analyze and design MIM diodes with the desired characteristics, we developed a simulator based on the transfer-matrix method, and verified its accuracy by comparing simulated I(V) characteristics with those measured in MIM diodes that we fabricated by sputtering, and also with simulations based on the quantum transmitting boundary method. Single-insulator low-resistance diodes are not sufficiently nonlinear for efficient rectennas. Multi-insulator diodes can be engineered to provide both low resistance and substantial nonlinearity. The improved performance of multi-insulator diodes can result from either resonant tunneling or a step change in tunneling distance with voltage, either of which can be made to dominate by the appropriate choice of insulators and barrier thicknesses. The stability of the interfaces in the MIIM diodes is confirmed through a thermodynamic analysis.

Number of references:41
Main heading:Current voltage characteristics
Controlled terms:Band structure - Diodes - Electron tunneling - Metal insulator boundaries - Metals - MIM devices - Resonant tunneling diodes - Semiconductor insulator boundaries - Thermoanalysis - Transfer matrix method
Uncontrolled terms:Current voltage - Higher frequencies - Low resistance - Metal insulator metals - MIM diode - MIM diodes - MOM diodes - Non-Linearity - Quantum transmitting boundary methods - Rectennas - Step changes - Tera Hertz - Thermo dynamic analysis - Tunnel barrier -

Tunneling distance - Ultra-high frequency

Classification code:531 Metallurgy and Metallography - 714 Electronic Components and Tubes - 714.2 Semiconductor Devices and Integrated Circuits - 801 Chemistry - 921 Mathematics - 933 Solid State Physics

DOI:10.1016/j.sse.2011.09.004

Database:Compendex