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

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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