Public Abstract

First Name: William

Middle Name: Clayton

Last Name: Nunnally

Adviser's First Name: Greg

Adviser's Last Name: Engel

Co-Adviser's First Name:

Co-Adviser's Last Name:

Graduation Term: SP 2008

Department: Electrical Engineering

Degree: PhD

Title: Magnetoresistance in Semiconductor-Metal Hybrids

Extraordinary magnetoresistance (EMR) in semiconductor-metal hybrids has been studied exclusively for sensor applications. However, some properties of EMR-based devices are potentially advantageous for power applications. This paper presents the theory, implementation, and results of a PSPICE finite-element model applied to an externally-shunted van der Pauw (vdP) plate.

Two prototype metal-semiconductor hybrid topologies for power applications have been derived from EMR sensor technology and are examined here for the first time, the shunted Corbino plate (SCP) and the externally-shunted Hall plate (ESHP). The PSPICE FEM model was used to analyze MR behavior as a function of geometric ratios characteristic of each new topology and semiconductor material properties. Pulsed-current and breakdown limitations are modeled .

The largest room-temperature MR ($\Delta R/R_o$) calculated for each prototype topology was approximately 2000% at 1 T. Current concentration caused by the inclusion of a shunt was found to limit the pulsed current capacity in each device studied. The best candidate, in terms of MR, from the SCP family showed a 1-ms pulsed current capacity of 323 A. In contrast, the pulsed current capacity of the best ESHP device was found to be 82 A. The best device geometries in terms of MR showed the lowest breakdown voltage among each set, both near 200 V. The data set presented here is useful for characterization purposes. But also, these findings and the unavoidable trade-off between magnetic sensitivity and breakdown voltage indicate that potential advantages are offset by intrinsic limitations in the use of the EMR effect for power applications.