Current Perpendicular-to-plane GMR for Magnetoelectronic RAM

K. Bussmann, G.A. Prinz, S.-F. Cheng  
Naval Research Laboratory, 4555 Overlook Ave SW, Washington, DC 20375 USA  
J.-G. Zhu, Y. Zheng  
Carnegie-Mellon University, Pittsburgh, PA 15213 USA  
J. M. Daughton, R. Beech, D. Wang  
Nonvolatile Electronics Inc., 11409 Valley View Rd. Eden Prairie, MN 55344 USA  
R. Wemack  
High Density Circuits, 7820-2 Pan Am 'n East Fwy NE, Albuquerque, NM 87109 USA

Introduction

Different avenues are being explored to realize non-volatile high density magnetoelectronic memory. Our work has focused on the applicability of the current perpendicular-to-plane configuration of magnetic multilayers showing giant magnetoresistance (CPP-GMR). Successful realization relies on overcoming several technological hurdles that include understanding the complicated transport characteristics and micromagnetics of the multilayer system, device fabrication, process integration to Si electronics, and the memory operating mode and architecture. In this work we present our results to date in our evolving approach to constructing a functional memory.

Experimental

Fig 1. Basic sense line memory architecture.

Fig 2. CPP-GMR MRAM layout.

Pseudo-Kelvin measurement of the device resistance by passing the voltage excited by a sense line current through a bit to neighboring sense lines. The sense lines are connected to electronics operating at the borders of the magnetic array that are designed to differentially amplify the device signal and level-shift to standard I/O values. The all-metal construction of the magnetics allows simple processing steps in realizing the arrays. We have optimized a process for this architecture that utilizes various steps of chemical-mechanical polishing and ion beam milling that produces negligible contact resistance between the device and overlay metal lines. Magnetic mesas, typically multilayers of (NiFeCo/Cu/CoFe/Cu)n resting on a copper underlayer, have been made with lateral dimensions down to 0.2 x 0.6 μm.