Materials Research for Advanced Data Storage

University of Alabama
Center for Materials for Information Technology

Fall Review
November 18, 2002
Center for Materials for Information Technology (MINT) at The University of Alabama

• A multidisciplinary research program focusing on new materials for advanced data storage.

• 22 faculty, 10 postdocs, and 40 graduate students from 7 academic programs in science and engineering.

• Support – federal grants (including an NSF Materials Research Science & Engineering Center grant), industry (IBM, Seagate, Quantum, Sony, Fujitsu, Hitachi Maxell, INSIC), and University support.
Materials Research for Advanced Data Storage

• Fundamental Materials Problems in Magnetic Data Storage
  – Storing
  – Writing
  – Reading
• Flexible Media Storage
• Molecular Storage
• Spintronics
TEM Images of Self-Assembled $[\text{Fe}_{49}\text{Pt}_{51}]_{88}\text{Ag}_{12}$ Nanoparticle Films

(25 $10^{12}$ particles/in$^2$)

Before Annealing

Annealed at 400$^\circ$C for 30 min

Contact: J.W. Harrell and Dave Nikles
Effect of Various Underlayers on $H_c$

$G$/Underlayer($t$ nm)/Fe$_{65}$Co$_{35}$ (50 nm)

Contact: Bill Doyle
CCP-CPP Spin Valves via Nano-Oxide Layers

AF(IrMn) → Cu → NOL (SiO₂) → CoFe → Cu

\[ \Delta R A_{\text{nom}} \approx 500 \text{mΩ} \mu m^2 \]
\[ \Delta R / R \approx 0.25\% \]

CPP GMR device with current path constricted by nano-oxide layers → increase \( \Delta R \cdot A \)

MR transfer-curve observed for a CCP-CPP structure with a nominal area of 50\( \mu m^2 \).

Contact: Hideo Fujiwara
Nanochannels via Nano-Oxide Layers (NOL)

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Contact: Hideo Fujiwara
Particle Ordering In Flexible Media

SANS Data

a) Fe 4.4% Nanoparticles in Cyclohexanone
   - Increasing
   - Decreasing
   \( H = 0 \) Oe

b) \( H = 90 \) Oe

c) \( H = 180 \) Oe

Model Predictions

a) \( \bar{H} = 0 \)

b) \( \bar{H} = 1 \)

c) \( \bar{H} = 2.5 \)

Contact: John Wiest
A Molecular Storage System

**project goal:** storage densities (2D) 10-100 Tb/in²

Research Team
- Si Blackstock
- Greg Szulczewski
Spin Transport in Confined Geometries

- **Nanocontacts**
  - Very large magnetoresistance from nanoscale constrictions

- **Nanowires**
  - Spin transfer effect

- **Nanocontacts**
  - CPP GMR with Confined Current Paths

- **Nanochannels**
  - Insulating layer with nanochannels
  - Pinned layer
  - 1-10 nm

Contact: Mankey, Schad, Zangari, Fujiwara
Ilmenite-Hematite as Magnetic Semiconductors

For 0.1 < x < 0.5, I-H is ferrimagnetic and semiconducting. The magnetic properties depend on the degree of order of the cation lattice.

Contacts: R. Schad and K. Pandey
Half-metallic ferromagnets

- Only known stoichiometric binary oxide that is a conductive ferromagnet at 300 K.

- Known to be a half-metal, i.e., 98.4 % spin-polarized at $E_f$.

Contact: Greg Szulczewski
THE UNIVERSITY OF ALABAMA

Half-metallic ferromagnets

Proposed device structure

Contact: Greg Szulczewski

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