Magnetic FePt Nanoparticles for Data Storage, Permanent Magnets and Bacteria Capture

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Drive to Develop High Density Storage Media

Material Requirements:
• uniformly sized particles or grains
• 8 – 10 nm diameter
• particles isolated in terms of exchange interaction
• “In short, the medium should be a densely packed particulate-like structure.”

FePt thin film properties:
• $K = \sim 5 \cdot 10^7 \text{ erg/cm}^3$
• $H_c = \sim 10,000 \text{ Oe}$

FePt Thin Films by Vacuum Deposition

- Film can be cosputtered or elements deposited sequentially

As deposited

After annealing

- $H_{C_{\text{max}}} = 9148$ Oe

FePt Nanoparticle Synthesis

- size tunable 3 – 10 nm
- FCC structure
- superparamagnetic at RT → must be annealed


Unannealed 4 nm FePt nanoparticles by TEM
Assembly of FePt Nanoparticle Superlattices

- **Solvent evaporation**

- **Non-solvent diffusion**
  - Methanol
  - 2-Propanol

- **Polymer mediated self-assembly**

Oleic acid/oleylamine → 5 nm spacing, HCP

Hexanoate/hexylamine → 1 nm spacing, cubic

Magnetic Properties of FePt Nanoparticle Superlattices

Effect of particle composition

\[ X \text{ in } \text{Fe}_{x} \text{Pt}_{100-x} \]
Annealed at \( T = 580^\circ \text{C} \) for 30 min

Effect of annealing temperature

Composition: \( \text{Fe}_{52}\text{Pt}_{48} \)
Annealed 30 min

FePt nanoparticle assemblies can support magnetization reversal transitions. Challenges:
• annealing without agglomeration
• orienting magnetic direction in assemblies

FePt – Fe$_3$Pt Nanocomposite Permanent Magnets

Energy product (BH) values:
- FePt-Fe$_3$Pt = 20.1 MG Oe
- FePt = 14.7 MG Oe
- Typical single phase hard magnets < 10 MG Oe

FePt Nanoparticles for Bacteria Capture

Captures:

- **S. aureus** 8 cfu/mL
- **S. epidermidis** 10 cfu/mL
- **CNS** 4 cfu/mL
- **E. coli** 15 cfu/mL

- Limit of current assays’ detection: 100 cfu/mL