Beyond 1Tbits/in² – the Future of Recording Media Technology

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Bit Patterned Media

- Beyond 500Gbps: thermal fluctuation limit in conventional granular perpendicular media

- Tradeoff between maximum write field and medium coercivity
  - Write field saturation

- 1 bit on 1 magnetic dot
  - High thermal stability and low write field
BPM Fabrication Concerns

• EB lithography
  - Presentation of 25nm dot-pitch findings at MNE 2006
    ▪ Carixalene resist → low sensitivity
    ▪ Lengthy EB mastering period
  - Advanced resist materials of much greater sensitivity with high resolution needed

• Patterning using Self-assembly Materials investigated
  - Resolution not equipment dependant
Self-Assembly Material Templates

- Phase separation of PS and PMMA were applied to form periodic dot arrays
  - <10nm pitch dots arrays are possible
  - 10Tbpsi areal density is feasible
Guided Self-Assembly for BPM

- Combination of self-assembly with top-down lithography
  - Self-assembled dot alignment on designated tracks
Guided Self-Assembly Methods

- Defect-free dot alignment
  - Achieved using 2D guide method
R/W Demonstration on BPM

• Read/Write testing with flying heads
  – 80nm dot pitch

Circumferentially aligned CoCrPt dots fabricated on 2.5-inch HDD substrates using guided self-assembled methods

Read-back signal from flying head

Magnetic Force Microscopy image
Next Step: Transcending 5 Tbits/in²

- Dot diameter roughly <8nm
  - Exposure to BPM thermal fluctuation

- Heat-Assisted Magnetic Recording (HAMR) on BPM
  - Enables higher densities
Granular Structure Perpendicular Media with HAMR

- Thermal fluctuation occurs following heat spot exposure on the magnetic field
  - Accelerated thermal fluctuation during cooling process
HAMR on BPM

- HAMR on single domain magnetic dots lessens thermal fluctuation
  - Benefit of magnetic field suppression on the dot
HAMR-BPM Materials: FePt

T. Maeda:

Highly textured ordered FePt film: $\Delta \theta_{50} = 8^\circ$

- FePt materials selected for the HAMR-BPM research
Circumferentially-aligned FePt Dots

- 1Tbpsi-level requires 30 nm dot pitch
  - Fabrication successful across the HDD substrate
Microscopic Structure of FePt BPM

Sectional TEM Images

- No significant damage was observed
Self-assembling Periodic Pattern -- 3 Tbpsi

- 15 nm pitch periodic pattern was obtained
- 3 Tdots/inch² BPM fabrication is achievable
Summary

• Self-assembling polymer template methods for Tbpsi-level BPM fabrication demonstrated
• HAMR on BPM can lead to 10Tbpsi levels
• Fabrication of BPM using FePt and Co/Pd was achieved
  – Damage seems to be negligible
  – Research is continuing

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Thank you for your attention.