LMR And PMR Media Update

Presented by
Michael A. Russak, Ph.D.
President & Chief Technical Officer

Komag Inc.
1710 Automation Parkway
San Jose, CA 95131
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Outline of Presentation

- LMR Media for 160 GB/Platter Products
  - State-of-the-Art Media
  - Where to expect SNR to come from
  - Low MrT, thermally stable TMR media
- Komag’s Perpendicular Media
- Current Status:
  - CoCrPtBO-media
    - Storage Layer
    - Interlayer
    - SUL
- Summary
Issues and Challenges for LMR Media

- While a lot of effort is being focused on PMR media development, the bulk of our efforts is still in LMR media.
- SNR improvement is more likely to come from narrowing the transition parameter than by grain size reduction.
- From a media perspective, $H_c$, $MrT$ and overcoat thickness are extrinsically bounded.
- Grain size uniformity and OR are key features to improve the transition parameter in media.
- Introduction of TMR heads allowing $MrT$ reduction, while challenging, opens up opportunity for further improvements in SNR.
SNR Vs. Grain Size and Transition Parameter

\[ SNR = 10 \log \left( 0.31 \frac{PW_{50}BW}{a^2 S} \right) \]

At 125 Gb/in² products there is opportunity to reduce transition parameter with lower MrT media with use of low noise TMR heads.
SAF LMR Media Structure

Strong focus on nucleation layer and exchange layers for grain size uniformity and thermal stability
HRTEM Image of LMR Mag. Layer

<\text{G.S.}> = 6.0 \text{ nm}; <\text{C.C.D.}> = \sim 8.0 \text{ nm}
State-of-the-Art Media Microstructure

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SNR Improvement Through OR

Sample 1  Sample 2

Line scan for texture line density

200 nm  200 nm
SNR Improvement Through OR

Sample 1:

60 texture line/1 µm

MrT OR: 1.7

Sample 2:

65 texture line/1 µm

MrT OR: 1.8
LMR Media Improvement Path

- Grain Size reduction cannot be too aggressive from now on.
- Grain size uniformity will improve as we refine process in complex SAF media stack.
  - Through UL and,
  - Nucleation layer processing.
- Most media SNR gains will be realized through slimming of the transition parameter.
- Lower MrT (~ 0.3 memu/cm²) will be possible by introduction of low noise TMR heads.
- Thermal stability will be kept by:
  - Increasing MrT cancellation of SAF media.
  - Improving dHc/dT of the media alloy.
  - Improving grain size uniformity.
Final Thoughts on LMR

- 80 GB/Platter (~65 Gb/in$^2$) is mature technology but is still good for >1 year

- 100 and 120 GB/Platter technology is starting to ship (shortly) and will live for (1-2 ?) Years

- 160 GB/Platter drives are not just ready yet but they are on LMR platforms.

  Granted that PMR may be introduced in 2005 in small programs (and small form factors) but …. 

- LMR has at least 3 more years of life and will probably co-exist with PMR for a few more years before PMR takes over completely.
Perpendicular Media
PMR Introduction

• Technology hurdles in PMR technology are no longer show stoppers.
• However, PMR technology still faces major problems, e.g.,
  • Media/Head manufacturability (mainly media)
  • Wide area track erasure
  • Channel technology
  • Servo writing
  • Magnetic state of the finished media (e.g., DC or AC magnetized?)
  • SUL magnetic directionality setting
  • Mechanical reliability

• Given the plethora of problems and unknowns, the first PMR programs will be very small.
PMR Introduction

• At the media level, many problems remain to be solved before we can be ready for manufacturing,
  • SNR improvement.
  • Better uniformity and throughput/utilization.
  • Domain-free magnetic soft underlayers.
  • Bulk erase process for AC remanent state.
  • Robust tribology.
CoCrPt-Oxide Perpendicular Media Structure

- Overcoat
  - CoCrPtO Hard Magnetic Layer (~15 nm)
  - Ru (10 – 20 nm)
  - Seed Layer
  - Soft Magnetic Layer (60 – 120 nm)
  - Substrate (AlMg or Glass)

Inter-layers
Typical Layer Thickness in PMR Media

- 15.5 nm
- 14.3 nm
- 2.1 nm
- 95 nm → 45 nm
- 95 nm → 45 nm
- 191 nm → 91 nm
- 0.9 nm

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Plan-view Bright Field TEM Image & SADP
Nucleation Layer

- We’ve developed a new family of nucleation layer structures that allow us to reach much higher Hc.
  
- These new NLs also provide smaller magnetic grain sizes and more magnetic grain isolation.
  
- Media SNR gain is ~ 1 dB.
  
- Overall NL thickness is still large (minimum at ~14 nm).
  
- Need to develop a <10 nm process.
NL Thickness is the same among these samples
Perpendicular Media: SNR Evolution

SNR [dB]

Time [months]

- Boron Alloy Media
- Oxide Alloy Media

Dec. 2000

+ 11.6 dB

- 6 dB

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Summary

• LMR will be extendable to at least 150 Gbit/in²
  - TMR HEADS
  - Adjustable Fly Height

• SAF structures will be the end for LMR

• PMR will penetrate in SFF, low volume HDD programs
  - Toshiba 48mm – mid-2005

• PMR still in need of process and performance improvement