MAGNETIC RECORDING TECHNOLOGY

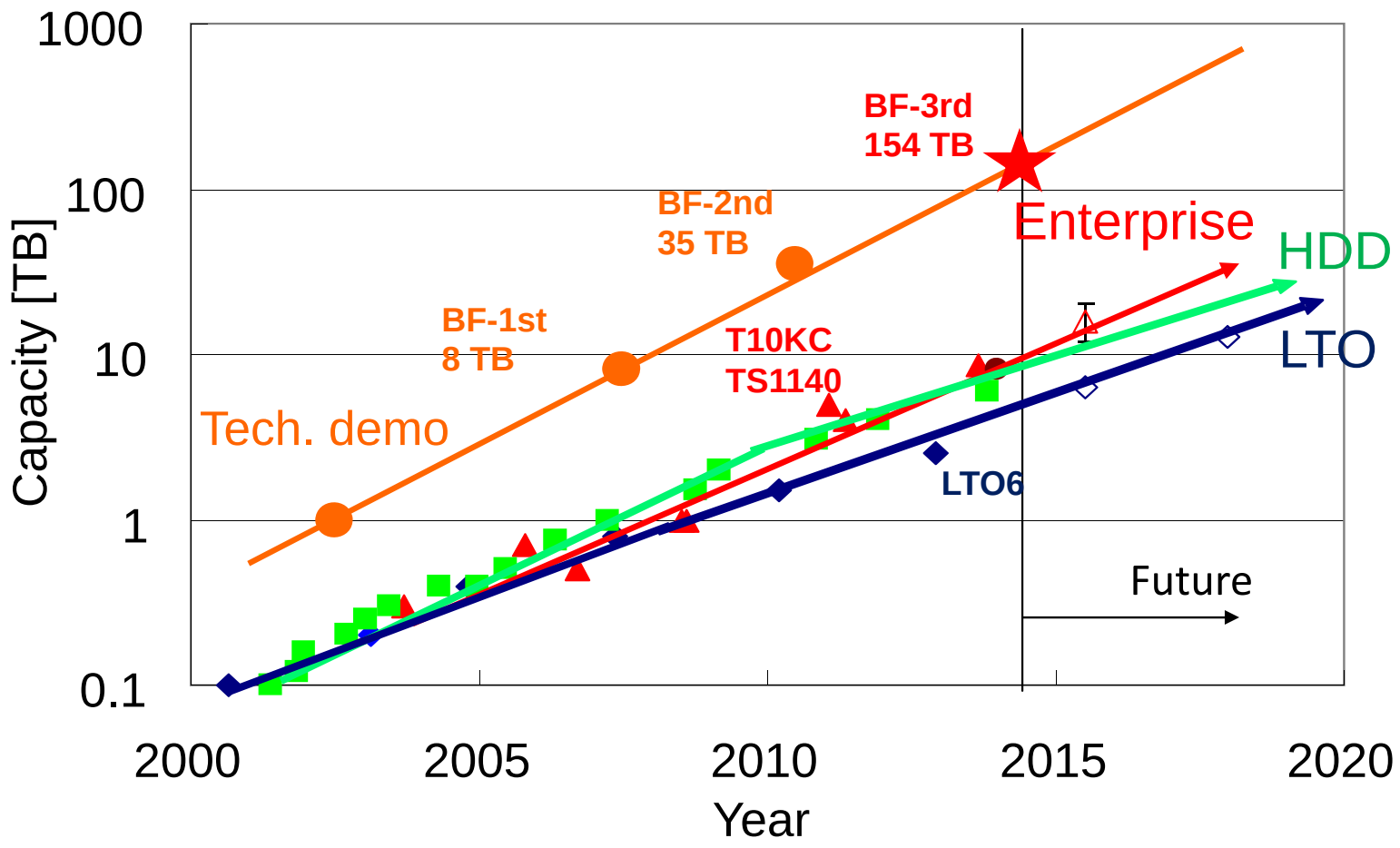
What's Ahead for Tape?
A critical review, by Ric Bradshaw, PhD

Fujifilm Executive Summit
New York City, Sept, 2014

Outline

- Technology trends & future requirements for Tape Media
- Competitive technology assessments for Tape Media
- Exploratory research opportunities

Capacity Trends of Tape Storage



Current Technology

- Particulate coatings on web coating lines allow long films to be produced by the kilometer every few minutes
- Thin film media requires slow and expensive high vacuum systems suitable for batch production rather than continuous operation

Particulate Tape Technology Demonstrations

85.9 Gb/in^2 recording bit density

IBM/FujiFilm technology demo

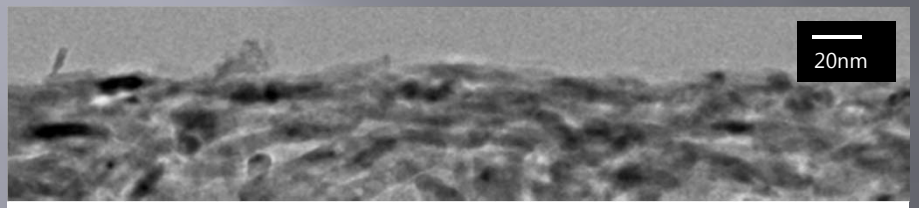
May 2014

Advanced BaFe media (BF-3rd)

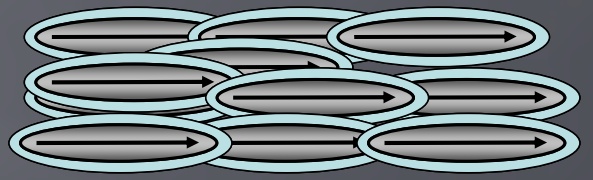
Prototype high field GMR head with 90nm read width

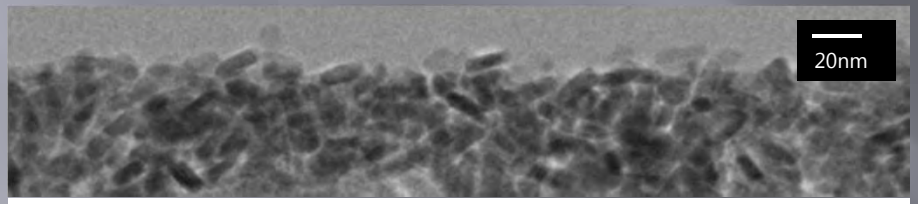
Advanced servo format and signal processing technologies

Particle Orientation and Packing

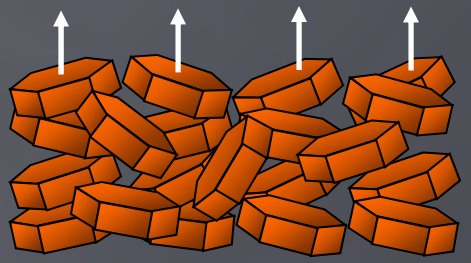


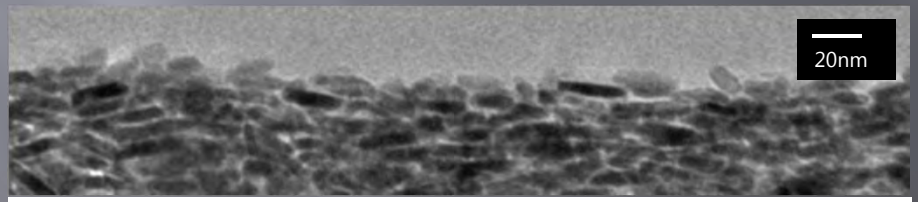
Longitudinal orientation(Latest MP)



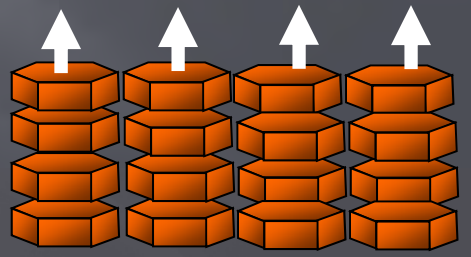


Perpendicular orientation (BF-1st)



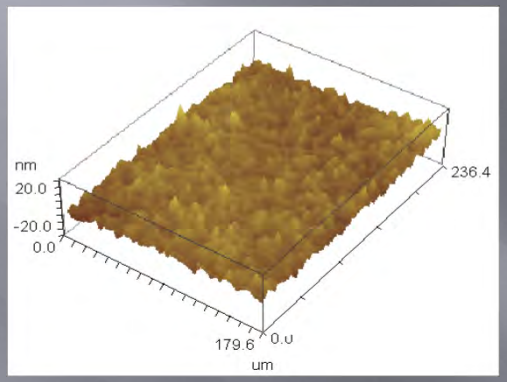
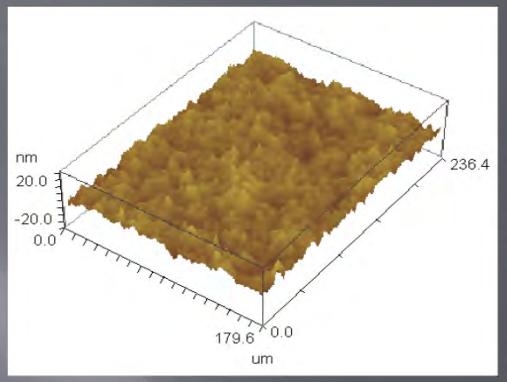
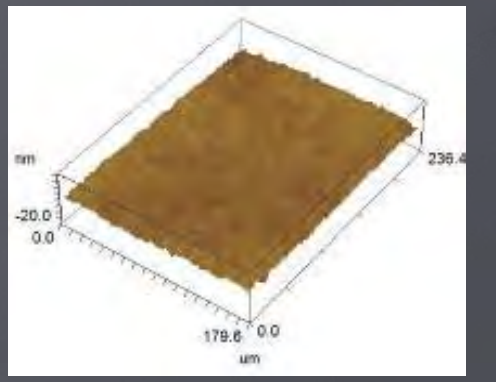
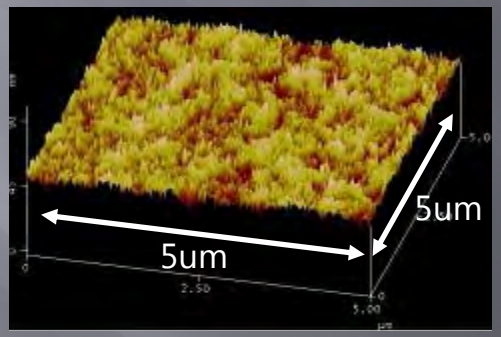
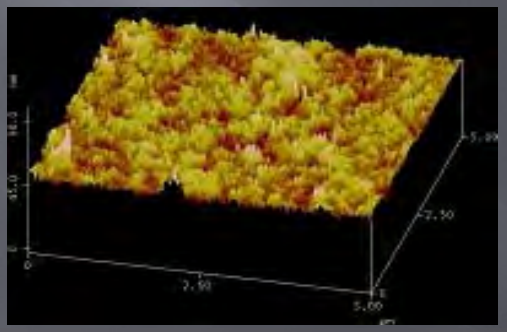
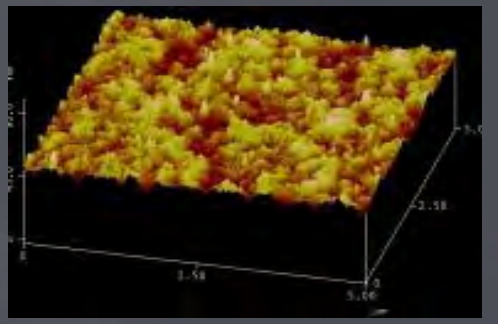


High Perpendicular orientation (BF-3rd)



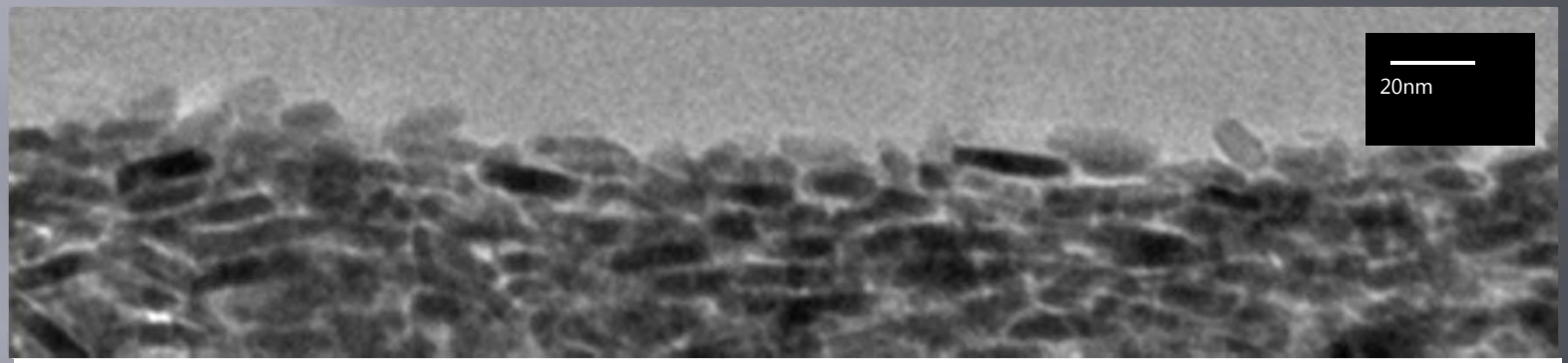
- By changing magnetization orientation from longitudinal direction to perpendicular direction, the areal density will increase significantly.

Surface Profile

	Latest MP	BF-1st	BF-3rd
Optical interferometry roughness meter			
	Ra 2.0nm	Ra 2.0nm	Ra 0.8nm
AFM			
	Ra 2.4nm Rz 29nm	Ra 2.0nm Rz 27nm	Ra 2.0nm Rz 22nm

- BF-3rd shows a predominately smooth surface.

Particulate Media Demo



BaFe particles are stable and formulated for optimum magnetic recording properties by Fujifilm with the goal of supporting future product needs at least several generations beyond current products

Web coating process allows continuous manufacture of long strands of media with inherently better process control than batch processes

Slitting of wide coated web does not destroy recording layer integrity

No high vacuum coating process environment requirement

Thin Film Media Technology Demonstration

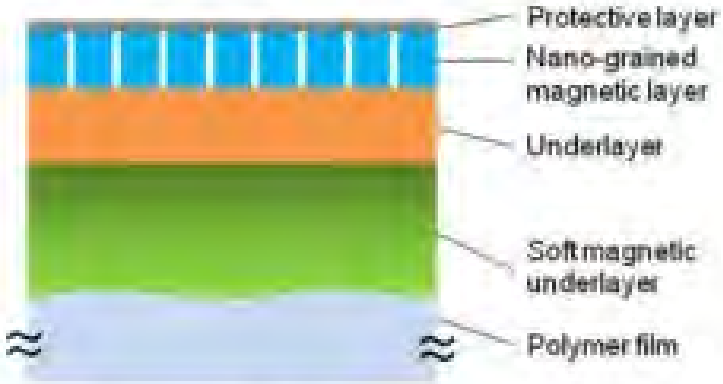
148 Gb/in^2 recording bit density

SONY/IBM technology demo May 2014

Ultra high vacuum sputtered multi-layer metal film with a soft magnetic underlayer similar to that used HDD coatings

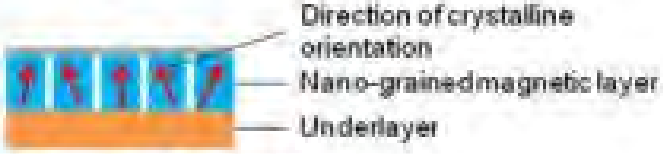
Thin Film Process Media

Cross-section structure (image)



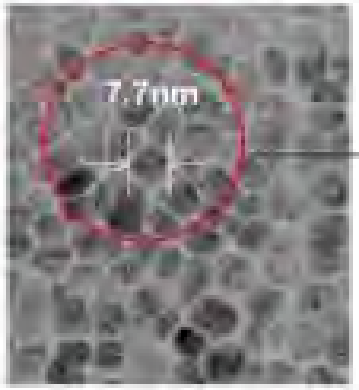
Comparison of Crystalline orientation (image)

< Uniform crystalline orientation (Sony's results)>



< Ununiform crystalline orientation >

Image capture of resulting magnetic particles (top layer)



Comparison of magnetic particle size (image)

Thin Film Tape Technology

Thin film media recording simulation

(Josef Fidler, Vienna University of Technology,
INSIC Tape Project)

Thin Film Media Technology

- Demonstrates the density and signal enhancements achievable for perfectly oriented and ordered coatings.
- The dominant technology in hard disk drives
- Not competitive from a quality, durability or cost perspective with particulate coating process tapes

Research Opportunities

- New particles, smaller, higher magnetic moment, improved thermal stability and switching field distribution (narrow size distribution)
- Thinner and smoother recording layers
- Higher packing fraction and ordering of particles
- Monodisperse particle emulsions self-assembled into coatings which mimic thin films but with the process ability and stability of particulate coatings

Thin Film Tape Technology

Advanced (optimum) BaFe media recording simulation

(Josef Fidler, Vienna University of Technology, INSIC Tape Project)

The Future of Tape

- SONY thin film demo indicates potential of new coating approaches for particulate coating formulations which avoid the problems with thin film tape coatings

- Smaller, more uniform BaFe or completely new particles (MnAl) may allow significant improvement in magnetic recording layer properties without sacrificing stability, durability and cost


The tape universe…
expanding with the needs of mankind …..now and into the future!