Perpendicular Magnetic Recording
Histerezy przebiegu funkcji magnetycznej

Disk Technology/ AFC Media Response to Magnetic Field

AFC media magnetization response to magnetic field

CoPtCrB
Ru
Cr
underlayers
Glass substrate

M_{rt\text{top}} = 0.31
M_{rt\text{bottom}} = 0.09

M_{rt\text{top}} = 0.31
M_{rt\text{bottom}} = 0.09

M (emu/cm^2)

H (kOe)

Osłona prowadząca głowicę
Evolution of Magnetic Read/Write Sensors

1970
Ferrite Inductive MnFe Read/Write Head
Wire wound coil
Machined Pole Pieces
Gap Width Controlled by Films And Assembly Tolerances

1980
Thin Film Inductive Read/Write Head
Coil, Pole Geometries
Controlled by Semiconductor Type Process
NiFe Poles
Two Contact Structure

1990
Thin Film Inductive Write MR Read Head
Write Wide-Read Narrow
Four Contact Structure
SAL NiFe MR Film

1997
Thin Film Inductive Write GMR Read Head
Write Wide-Read Narrow
Four Contact Structure Pinned, Free Films Antiferromagnetic Exchange Film CIP Operation

>2003
Perpendicular Thin Film Inductive Write CPP Read Head
Geometria głowicy zapisującej
A Magnetic Media Roadmap

- Conventional Longitudinal Media
- AFC Longitudinal Media
- Perpendicular Media
- Range of Future Values
- Patterned Media

Areal Density, Gbits/in² vs. Product Ship Year
Patterned Magnetic Media
Fig. 2. Cross-sectional TEM image of the CoPt patterned media. Each dot has a diameter of 40nm. Grey portion between the dots are SOG (SiO2) and white portion on the dots is C over coat.
Produkcja Patterned Media

SEM picture shows the Blu-ray master disk made by EBR. The linewidth is 150nm.
Produkcja Patterned Media

RIE – Reactive Ion Etching

SEM images of the DTR structure in nickel intermediate polymer stamp (IPS).
Produkcja Patterned Media

NIL – Nano-Imprint Litography

ultraviolet light

transparent stamper (inverted)

disk substrate

liquid nanoimprint resist

RIE etching plasma

disk substrate

hardened nanoimprint resist pattern
Jak osiągnąć rozdzielczość 27nm (gęstość upakowania 1Tbit/sq. Inch i większa)...

Produkcja Patterned Media
Produkcja Patterned Media

...stosując self-assembling block copolymers!

Figure 2: Cylindrical phase block copolymer thin films. A) SEM micrograph of a Polystyrene-b-methyl methacrylate) (PS-b-PMMA) block copolymer. B) Cartoon representation of the block copolymer film with PMMA cylinders in blue and a PS matrix in yellow. C) top-down view of B).
Produkcja Patterned Media

Figure 3: Process to create lithographically-defined chemically pre-patterned surfaces and subsequent directed assembly.
(A) Electron beam lithography patterns at $L_s=Lo$ (left) and $L_s=2Lo$ (right).
(B) Chemical contrast on the substrate after O2 plasma exposure on the e-beam defined spots above. (C) Block copolymer thin film. (D) Guided self-assembly in registration with the underlying chemical pattern.
Produkcja Patterned Media

Figure 4: (A-D) SEM micrographs of developed e-beam resist with $L_s=39, 78, 27$ and 54nm respectively. (E-H) SEM micrographs of the block copolymer film on top of the pre-pattern defined by the corresponding e-beam pattern above. The lattice pitch on the block copolymer samples is $L_p=39, 39, 27$ and 27 nm, respectively. (I-L) Dot size distribution of e-beam (dark teal) and guided block copolymer patterns (light green).
Figure 6: Pattern transfer using a directed block copolymer template with density multiplication ($L_p=39\text{nm}$, $L_s=78\text{nm}$). (A) Cr dots after lift-off. (B) 20 and 30nm tall Si pillars etched using the Cr mask in (A).