NANO³ Technology Seminar – May 2006

Fujifilm NANOCUBIC™ Coating Technology - Potential For 8 TB Data Storage Tapes.

Fujifilm U.S.A., Inc. – Recording Media Division
200 Summit Lake Drive - Valhalla, NY 10595-1356
Customer Service: 800-488-3854

Web Site: www.fujifilmusa.com/tapestorage
Technology change to NANO³ (NANOCUBIC™) technology

MV is the metal particle (MP) tape that Fuji Photo Film Co., Ltd. developed as video tape in 1981 when tape with a coating of ferrocobalt oxide was widely used for video tape recording.

ATOMM is the super-thin layer coated metal particle media that Fuji Photo Film Co. Ltd. introduced in 1992.

New NANOCUBIC technology – its nano-thin layer of magnetic particles make it possible to record digital data at exponentially higher densities.
NANOCUBIC technology is an ultra-thin layer coating that results in higher resolution for recording digital data, ultra-low noise and high signal-to-noise ratios that are ideal for magneto-resistive (MR) heads.

NANOCUBIC Coating Technology precision coating at recording layer thicknesses below 100 nanometers enables recording densities more than 10 times higher than standard magnetic layers – potential for 8TB data storage and digital video tapes, plus 20GB flexible magnetic disks.

Fujifilm will continue to develop ATOMM technology products for use in inductive-head and MR-head systems. NANOCUBIC technology products will be developed for MR, GMR and TMR head systems.

NANOCUBIC coating technology can be applied cost-effectively to mass production manufacturing processes, requiring only small modifications to current ATOMM Technology coating equipment.
Evolution of Recording Density with Magnetic Layer Coated Recording Medium

Figure 2

- NANO³ (NANOCUBIC) Technology
- ATOMM Technology
- MP Technology

Recording Density (Gb/in²)

Year:
- 1980
- 1990
- 2000
- 2010

Recording media:
- Ferrite head
- MIG head
- MR head
Three Technologies of NANO$^3$ (NANOCUBIC) Technology

- **NANO Coating Technology:**
  - NANOCUBIC technology employs an advanced precision coating process that can control the thickness of the magnetic layer on a nanometer scale.

- **NANO Particle Technology:**
  - Two types of magnetic particles were developed for NANOCUBIC technology, both tens of nanometers in size. The products will use one particle or the other particle, depending on the application:
    - acicular ferromagnetic alloy particle
    - tabular ferromagnetic hexagonal barium ferrite particle

- **NANO Dispersion Technology:**
  - NANOCUBIC technology uses a special organic binder material that has the ability to thoroughly disperse particles in the coating solution so that a uniformly packed structure of the layer is realized.
NANO Coating

Base Film

Non Magnetic Layer

Magnetic Layer

Magnetic Liquid with NANO Dispersion
Construction of NANO³ (NANOCUBIC™) Technology

MP (Single Layer MP)

ATOMM Technology

NANO³ (NANOCUBIC™) Technology

Fig. 4
Photograph of Cross-Section of Tape

ATOMM Technology

NANO3 (NANOCUBIC) Technology

Magnetic Layer

Non Magnetic Layer

Base
High Resolution

In order to achieve high density recording, the isolated pulse shape must be very sharp, produce little jitter and have a narrow width at its 50% threshold ($PW^{50}$).

$PW^{50}$ is reduced by using a very thin magnetic layer.
Photograph of Magnetic Particle

**ATOMM Technology**
- MP

**NANO³ (NANOCUBIC) Technology**
- MP
- Barium ferrite
Modulation Spectrum

Relative speed: 8.2 m/s
Recording Signal: 180 kfc
This photograph is an observation of the recorded tape tracks magnified by MFM. (Magnetic Force Microscope) MFM observes the intensity of the magnetic field which occurs from the recorded tape directly. Sharper pattern image of MFM means higher resolution media.
Fujifilm NANO³ (NANOCUBIC™) Technology

- Fujifilm announced nanocubic™ Technology on November 6, 2001 and had begun to work with drive manufacturers to develop new, high capacity magnetic storage products using nanocubic technology.

- On May 13, 2002, IBM announced that it has recorded 1 terabyte of data to a linear tape cartridge, using Fujifilm’s nanocubic media as a key component of their 1TB linear tape technology development.

- On July 22, 2003, Iomega announced the Digital Capture Technology platform based on a 1.8 inch flexible disk having a capacity of 1.5 GB using Fujifilm nanocubic magnetic media coating technology.

- On September 9, 2003, IBM began shipping the Enterprise 3592 Tape Drive and Data Cartridge based on 2000' x half-inch nanocubic media, which has a native capacity of 300 GB.

- On October 26, 2005, IBM introduced a new model 3592 Drive that can store 500 GB native on the same “300 GB” nanocubic cartridges, which have been shipping since September 2003.

Web Site: www.fujifilmusa.com/tapestorage
On November 4, 2005 Fujifilm announced production of new Sun StorageTek T10000 media incorporating NANOCUBIC technology. A single cartridge designed for the Sun StorageTek T10000 Tape Storage system provides 500 GB capacity (uncompressed).

On May 16, 2006, IBM announced they had demonstrated a world record in data density on linear magnetic tape. IBM packed data onto a test tape at a density of 6.67 billion bits per square inch, more than 15 times the data density of today's magnetic tape.

IBM announced that this world-record achievement leverages new high-density dual-coated particulate magnetic tape media developed by Fuji Photo Film Co., Ltd., in Japan in collaboration with IBM Almaden researchers. This next-generation version of Fujifilm’s NANOCUBIC™ tape uses the barium-ferrite particle.

When products become available, projected in about five years, the drive and media technology will allow cartridges the size of an industry-standard Linear Tape Open (LTO) tape cartridge to hold up to 8 trillion bytes (8 terabytes) of uncompressed data.

Web Site: www.fujifilmusa.com/tapestorage
Think Fujifilm Media, for Today’s & Tomorrow’s Most Popular Drives!

Thank You!

Advanced super Thin-layer and high-Output Metal Media

nanocubic
Fujifilm began coating motion picture and photographic film in the mid 1930’s using die coating technology. Simultaneous multi-coating technology was developed in 1960. Also in 1960, Fujifilm produced its first magnetic tape products. In 1965, Fujifilm began manufacturing computer tape. Fujifilm’s floppy disks (8-inch) were introduced in 1977. Fujifilm began manufacturing dual-coated magnetic media in 1989 and Advanced super Thin-layer and high-Output Metal Media (ATOMM) dual-coated media in 1992. For ATOMM, Fujifilm’s special die coating head simultaneously applies two separate and unique layers, one magnetic and one non-magnetic. It’s a dual coating system Fujifilm invented that has allowed us to continually develop the industry’s “next generation” storage products and develop nanocubic™ Technology for data storage products with even greater capacities.