FUJIFILM
I&I – Imaging & Information
Fuji Photo Film U.S.A., Inc.
555 Taxter Road
Elmsford, N.Y. 10523
FUJIFILM NEWS

Fuji Photo Film U.S.A., Inc.

NANO CUBIC Technology Backgrounder

Overview

To meet the challenges of a market characterized by its demand for greater levels of storage capacity for both data, broadcast and consumer video content, Fujifilm has developed a unique coating for magnetic media called NANO CUBIC technology. This new process for the production of nanometer-scale, fine particle, thin-layer coated magnetic recording media utilizes Fujifilm's established resources and expertise in the development and manufacture of thinner coatings for film, data and imaging technologies.

By applying this new technology, Fujifilm is planning future product development that could potentially include tape with a native, uncompressed recording density of more than one terabyte. This figure is ten times larger in capacity than currently achieved for conventional tape. Product development could also include flexible magnetic disks with a storage capacity of 3 gigabytes.

In 1992, Fujifilm developed its ATOMM (**A**dvanced super **T**hin-layer & high-**O**utput **M**etal **M**edia) coating technology for magnetic recording media, which subsequently led to the introduction of benchmark products that helped shape today's data and broadcast storage markets. These products include DLTtape™ IV, DDS3, DDS4 and LTO Ultrium™ 1 data cartridges and Zip®100, Zip® 250 disks as well as Hi-8 Super DC, DVCPRO and Digital-S Videotapes. The breadth and depth of products in these markets demonstrates Fujifilm's leading role in offering advanced media recording technologies to industry over the past decade.

Now, utilizing NANO CUBIC technology as the basis for its next generation recording media production technology, Fujifilm has succeeded in prototyping a high resolution, low noise (S/N) ultra-thin magnetic layer media capable of high resolution, high density performance when partnered with MR (magneto-resistive) head technology. During the technology development process, the increase in linear recording density was achieved in two ways: first, by employing particles with nano order microstructures, it is possible to sharpen flux reversals, thus narrowing an isolated pulse width at 50 percent threshold

(PW_{50}) increasing signal resolution, and second, by reducing the low frequency output while increasing the high frequency output for a flat frequency response. This is all accomplished by reducing the thickness of the magnetic layer.

Reducing media noise as a component of system noise is very effective in improving S/N results and two magnetic materials were developed for this purpose: ultra-fine acicular ferromagnetic alloy metal particles and ultra-low noise barium ferrite particles. Since these magnetic particles can be packed with greater density and aligned more uniformly, it is now possible to produce magnetic layers with greatly reduced media noise.

The result of these breakthroughs is that NANO CUBIC technology can realize more than 3 Gb/in^2 in recording density (see figs. 1 and 2 in accompanying presentation).

Although Fujifilm's ATOMM technology made sub-micron metal coating possible, the thickness of the newly developed nano-thin layer coated magnetic recording media is even thinner, by a factor of 10 than that of the ATOMM media. The new NANO CUBIC technology also is expected to contribute greatly to the development of future high-capacity recording systems because of the technology's superior adaptability to high-sensitivity MR, GMR and TMR heads.

Fujifilm made the following technological breakthroughs in the development of NANO CUBIC technology:

1. **Nano-coating:**

   The ATOMM coating technology has been further developed to produce a thin coating layer on nano-meter scale (see fig. 3). With the ATOMM technology, a sub-micron magnetic layer is coated simultaneously onto a non-magnetic layer. This new technology follows a similar simultaneous coating method, which produces an ultra thin magnetic layer about one-tenth of the thickness of the magnetic layers produced with ATOMM technology (see figs. 4, 5). As a result, an isolated pulse can be reproduced with sharper resolution and with a PW_{50} that has been decreased to 40 percent of that achieved under ATOMM technology. Recording density can be increased by more than 10 times (see fig. 6), and a flat frequency response can be achieved by optimizing the layer's properties to take advantage of the high-sensitivity performance of MR head technology.

2. **Nano-particle:**

Two types of magnetic particle -- with sizes to the order of tens of nanometers -- have been developed to effectively reduce media noise and to increase recording bit density. The first is an acicular ferromagnetic alloy particle of a few dozen nanometers in size, about one-half the size of an ATOMM-based particle. The second is a small, tabular ferromagnetic hexagonal particle of barium ferrite material (see fig. 7) known for its unique magnetic orientation. Barium ferrite particles are ideal for increased packing densities and improving low noise characteristics. These nano-particles have achieved a 10 dB improvement in S/N at high linear density, compared with their high output (see fig. 8). Depending on the application, either the metal particle or the barium ferrite particle can be chosen in the design of the next generation recording system. Barium ferrite is well suited for use in higher bit density applications where low noise characteristics are necessary. The acicular shaped ferromagnetic metal particles are the best choice for higher output, narrower track-width designs.

3. **Nano-dispersion:**

A newly developed polymer compound binder is used to uniformly disperse the magnetic particles of a few dozen nano-meters in size in an orderly manner. This technique allows for the minute particles to chemically separate from each other avoiding flocculation of the materials in the suspension of binding materials. As a result, clear, more defined recording patterns can be realized at higher densities, which will be very significant for increasing recording capacity and expanding future applications for this technology (see fig. 9).

With no need to use vacuum evaporate facilities, Fujifilm's NANO CUBIC technology is capable of mass production with existing coating machines. Currently, Fujifilm is providing hardware manufacturers with media samples using this new technology, and through close cooperation with them, the company plans to co-develop new storage and archival systems, and will announce new products in the future.

Business Applications of Nano-thin Layer Coated Media

? Data tape:

? High-capacity linear recording tape, multi-track type tape

?High capacity helical recording tape

? Floppy disks:

?High-capacity floppy disks

? Video:

?High-definition, long-duration digital videotape for broadcasting

?High-definition, long-duration digital videotape for home use

? Data and video storage for home servers

About Fujifilm

Fuji Photo Film U.S.A., Inc., is the U.S. marketing subsidiary of Fuji Photo Film Co., Ltd., of Tokyo (FUJIY), a leading global manufacturer of imaging and information products. Recognized for its technical innovation and high quality, Fujifilm offers a complete portfolio of imaging and information products, services and e-solutions to retailers, consumers, professionals and business customers.

# # #