Imation Tera Ångstrom Technology

Angstrom surface smoothness for terabytes of data storage capacity

White Paper
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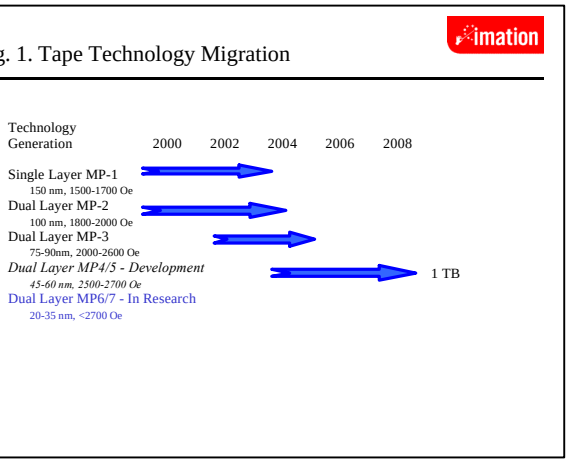
Imation is unveiling **Tera Ångstrom™ Technology**, a new revolutionary method of producing magnetic media that will enable future generations of tape technology media products with terabyte level storage capacities.

Magnetic tape has been the dominant technology used in the last 50 years to archive and store digital data. Imation (at that time 3M's Data Storage Division) was the first company to offer magnetic tape products for IBM tape drive systems more than a half-century ago, and Imation continues to be the leader of magnetic technology development today, offering the broadest portfolio of removable data storage products across all the segments – data center/enterprise, mid-range, small/medium business, and personal storage. Magnetic tape technology offers significant advantages over competing technologies, and current trends indicate that this will continue to be the case in foreseeable future. With increasing demand for digital data to be archived, there's great need to keep increasing capacity and transfer rate for data cartridges. This is accomplished with increasing bit and track densities on a given tape, and increasing the amount of tape in a given cartridge.

To enable the increasing bit and track densities, media manufacturers, such as Imation, have used increasing coercivity and smaller size acicular shaped metal particulate (MP) pigments for every successive generation of tape products. This is shown in Fig. 1, where each arrow represents a generation of MP technology and the timeline over which products that have been introduced using that technology. With continuous advancements accomplished in the MP technology development, we believe MP technology will be the most competitive technology for removable magnetic tape media in the foreseeable future – delivering 1 TB-capable native capacity cartridges in the next few years.

Fig. 1. Tape Technology Migration



Along with using more sophisticated MP pigments and the related formulation chemistry, the media processes that are used to enable the media to be produced play a significant role in the end properties of the media. The higher bit and track densities needed for future products necessitate media with high signal to noise ratio (SNR). This is accomplished through a thin magnetic layer on top of a non-magnetic layer or sub-layer coated on a thin flexible plastic substrate with a conductive backside coating. Table 1 depicts the thickness of the substrates and the coatings on the media, as well as the smoothness of the magnetic media that is anticipated in future technologies.

Table 1. Media Requirements Migration Path

Parameter	Units	MP 1	MP 2	MP3/4	MP4/5	MP6/7
Mag Layer Caliper	Micro-inches	40	12	8	2-4	<2
Sublayer Caliper	Micro-inches	N/A	70-90	70-90	40-60	<40
Backside Caliper	Micro-inches	25	20-25	20	10-20	<10
Substrate Caliper		18 -36ga	24ga	24ga	18 ga	<18 ga
Substrate Material		PEN/PET	PEN/PET	PEN/PET	PEN/PET	TBD
Mag Surface Roughness	Ra nm	6-10	4-6	4-5	3-4	<3
Bit Density	Kbpi	80 -190	90 -180	180-220	250-400	>400
Data Tracks	in 1/2" wide	350-600	300-400	500-600	1000-2000	>2000
Write Track Width	Microns	17-36	25-30	15	7-10	<7
Read Track Width	Microns	9-20	12-15	7	3-5	<5
Tape Length	Feet	800-2200	1500-2500	1500-2500	2000-3000	>3000

In order to develop magnetic media suitable for tape products, several proprietary steps are followed to ensure a high quality magnetic tape product. The process begins with creating dispersions of magnetic, non-magnetic and backside chemistries. To create these fine dispersions, the appropriate pigments, binders and other additives are milled together. These dispersions are coated using thin film coating techniques on a moving web at high speeds and dried using high temperature ovens. After coating, and during the process of drying, the magnetic particles are aligned in the direction of the moving substrate to further enhance the electromagnetic properties of the media. Once this is complete, the magnetic media is calendered in a stack of rollers to further improve the packing of the magnetic pigment and smoothness of the media, again giving a boost in the electromagnetic performance of the media. Subsequent to calendering, the media is slit into the desired tape width. This media is then servo-written and wound into cartridges.

Imation has developed Tera Ångstrom™ technology, a proprietary metal particulate advanced formulation and process to manufacture and develop magnetic media that leads to higher surface smoothness and higher SNR, therefore enable the higher capacity and transfer rates for future tape storage products. **Imation's Tera Angstrom Technology is based on three proprietary elements:**

1. **Impingement Process** using I-MUF particle high-pressure impingement technology to achieve nanometer size particles using >10,000 psi high pressure jets.
2. **Quiescent drying process** with low air velocity and magnetic coil orientation to achieve a high degree of particle orientation.
3. **In-line Calendering Process** to achieve surface smoothness on the order of Angstroms.

In each of these three areas, Imation's techniques provide a significant improvement in performance over conventional competitive approaches.

See Table 2 for the differentiating features of the Imation process and related benefits. Fig. 2 shows the particle size distribution achieved using conventional milling technologies such as homogenization, compared to Imation's I-MUF technology. I-MUF technology enables elimination of large size particles seen in conventional homogenization. Fig. 3 references the higher packing density and orientation that results from the quiescent drying and magnetic coil orientation process compared with conventional approach of using impingement drying and magnet orientation. The effect of in-line calendering with proprietary finished calender rolls is shown in Fig. 4 where it is evident that higher smoothness can be accomplished using the new process.

Table 2. Key Features of Imation Tera Ångstrom Technology

Tera Angstrom Technology - Features	Description	Benefit
Nanomagnetic Particles - high pressure (I-MUF) impingement process	High pressure (> 10,000psi) impingement of dispersions	Smaller particle size reduction and more uniform distribution
Quiescent Drying - magnetic coil orientation	Low air velocity plate drying with magnetic coils to orient particles	Smoother surface and high orientation ratio
Angstrom Level Surface Smoothness - utilizing proprietary calendering	In-line calendering using ultra-smooth (20-30 A Ra) proprietary rolls	Smoother surface

Fig. 2. High Pressure I-MUF Impingement

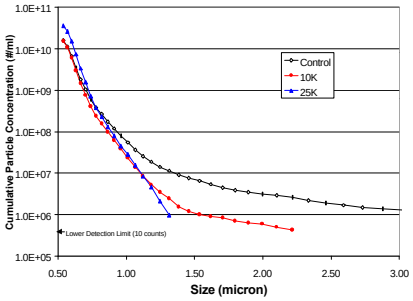
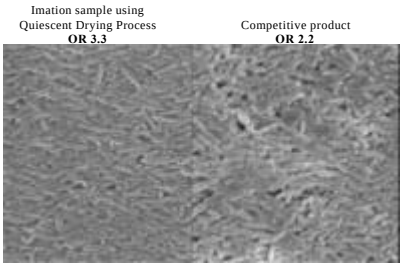
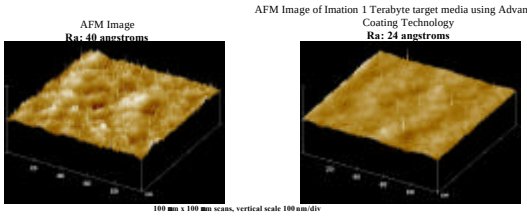


Fig. 3. Particle Orientation



SEM Images: 40,000x

Fig. 4. Angstrom Level Surface Smoothness



In summary, the new proprietary process, Tera Angstrom Technology, invented and developed by Imation will be the cornerstone for the development of future magnetic media products. The new process has been incorporated in the advanced media coating capabilities at its Weatherford, Okla., facility.

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