

# Industry-Leading Core Products and Technologies



GMR heads

*Creating new products is a company's social mission. But performing this role in the impending ubiquitous information society will require companies to skillfully integrate elemental technologies to satisfy diverse needs. TDK is doing that. And the result is total solutions encompassing products, systems and services.*

## Refining Core Technologies to Expand in Three Growth Fields

*Based on a strategy of prioritizing resources to invest in areas harboring strong prospects, TDK has pinpointed three growth fields in an electronics industry driving progress in ubiquitous information networks: IT home electronics appliances; high-speed, large-capacity networks; and car electronics. Leveraging its core technologies—materials technologies, process technologies, and evaluation & simulation technologies—TDK has won high marks around the world for providing advanced electronic components, electronic devices, systems and services to these fields.*

*Ubiquitous information networks will spawn a borderless, seamless networked information society. But beyond facilitating communication anytime, anywhere and with anybody on a worldwide scale, ubiquitous networks will also usher in another era—communication using any type of electronic device or equipment. All manner of electronic devices and equipment, from mobile phones and PCs to AV equipment, household appliances and car navigation systems, will communicate with one another based on the same interface specification. Amid this communication sea change, electronic component manufacturers must focus on creating more than just quality products if they hope to survive. Several aspects of developing products for finished product manufacturers are taking on greater importance: coming up with concepts and designs that provide accurate and timely solutions from the earliest stages of conceptual development and design, and providing solutions that anticipate future product trends. In a word, component manufacturers must be more than component manufacturers. That's what TDK is—and it's a business style that is becoming increasingly important.*

*Complex convergences of technologies in the ubiquitous era are expected to drive expansion in the previously mentioned three growth fields TDK is targeting. Evidence of this can already be seen in the IT home electronics market, with rapid growth centered on the so-called “three new consumer treasures”: digital still cameras, large flat-screen TVs and HDD/DVD recorders. And high-speed, large-capacity networks based on broadband communications and wired/wireless LANs are increasingly branching out beyond offices and homes to find their way into car electronics. Advances are also being made with mobile phones, which are evolving as sophisticated multimedia terminals that are a step up from mobile communications devices.*

*And with product life cycles growing shorter, seemingly by the day, the onus is on electronic component manufacturers to fashion flexible production systems. TDK has done that. Materials, process, and evaluation & simulation technologies, the source of TDK's competitiveness, allow the company to swiftly meet various market needs, including demands for strict quality management, short lead times and producing many varieties of products in small lots. Underpinning the continued competitiveness of these core technologies are close collaboration and personnel exchanges among operating divisions and a production system that skillfully integrates elemental technologies.*

*Guided by the mantra of being an Exciting Company, TDK is determined to continue innovating from the earliest stages of product development. TDK's ongoing drive is to be the quintessential e-material solution provider, one that boldly challenges the frontiers of innovation.*

### **Chris T. Burket, TDK Corporation of America**

*My job is to promote TDK's products where the IC maker can receive benefits by utilizing our components in his/her design. Designing in our leading-edge new products ensures that the IC maker is continuing to specify our products which are aligned in the direction we are moving. I believe that TDK will see the results of our sales promotion activities in the near future.*



## Magnetic Head Technology—Nanotechnology

### The Cornerstone of TDK's Competitiveness

Hard disk drives (HDDs) are tipped to benefit from an explosion in demand as applications widen. No longer is the HDD seen only as a storage device for PCs. HDDs are now finding a home in an increasing number of products, including car navigation systems, HDD recorders, and mobile devices.

iVDR (Information Versatile Disk for Removable usage), which uses 2.5-inch and lower HDDs, is currently attracting interest. Small enough to slip into one's pocket, iVDR is a removable HDD recorder that stores large volumes of data and can even record digital Hi-Vision TV broadcasts. It can be connected to PCs, AV equipment, and other electronic equipment.

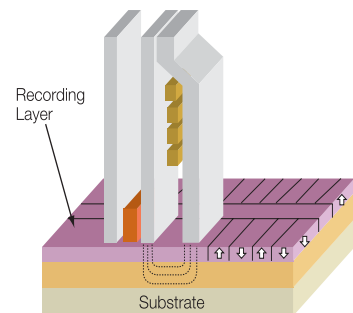
The iVDR highlights the rapid progress in recent years in making HDDs smaller. Two factors have contributed to this: hard disk materials with higher areal recording densities, and evolutionary advances in magnetic heads. The tip of the swing arm that reads the fast-spinning surface of the hard disk has been integrated with the slider, for example. As a world leader in magnetic heads, TDK has an integrated ability to produce many types of heads for HDDs, from HGA (Head Gimbal Assembly) to HSA (Head Stack Assembly). And TDK has developed a high impact-resistant head that can withstand forces of more than 1,000Gs during normal operation, approximately 5 times that of existing products, a breakthrough that has cleared the path to equipping mobile devices with HDDs.

Well before nanotechnology became a household word, TDK was consistently bringing to bear various elemental technologies at the nanometer level. Take the spin valve of current GMR (Giant-MR) heads with an areal recording density of 60Gbps (gigabit/square inch) as an illustration. The valve is fabricated by stacking many layers of film no thicker than a few nanometers. The TMR head (Tunneling-MR head) is another example. A next-generation head for the 100Gbps era, TDK's TMR head is produced by stacking layers of ferromagnetic and anti-ferromagnetic of only several nanometers between insulation layers less than 1 nanometer thick. In this microscopic world, even one improperly placed atom can disrupt the characteristics of an entire layer of thin film. TDK has also begun making use of perpendicular magnetic recording (CPP-GMR head), another next-generation technology, as it makes progress developing single-pole magnetic heads that can be fabricated using the same cost-efficient processes as used for integrated circuits. Through these and other efforts on the cutting edge of HDD head technology, TDK is aiming to make further strides in raising areal recording density.

TDK's treasure trove of materials technologies, leading-edge process technologies in the range of one-tenth of a nanometer, and the foresight to accurately read the unfolding market roadmap underpin its competitiveness as one of the world's preeminent manufacturers of magnetic heads.



A TMR head (Tunneling-MR head) through an electron microscope



An artist's impression of perpendicular magnetic recording



### CHAU Yiu Chung, SAE Magnetics (H.K.) Ltd.

*I work at SAE Magnetics (H.K.) Ltd., where we are endeavoring to improve production yields and quality in the production of HDD heads. Part of our mission is to enable TDK to meet customers' requirements on time and at the right price. At present, my colleagues and I are learning and exploring all about HDD heads, including details of TDK's long-standing involvement in this field. Through these activities, I'm confident that we'll be a company with stable growth and bright prospects.*

## Leading the Way in Compactness, Capacitance and Performance

### TDK's Multilayer Ceramic Chip Capacitors

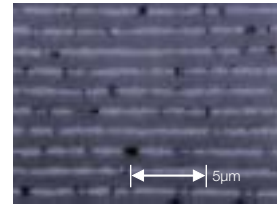
Chip capacitors are vital components in electronic circuits. Given that some 200-300 chip capacitors are used in a typical mobile phone, it is clear that downsizing chip capacitors can save considerable space and size and enable the addition of new functions. At present, 600 billion multilayer ceramic chip capacitors are produced worldwide every year, the vast majority of which are made by Japanese companies.

Multilayer ceramic chip capacitors are produced by printing electrode paste on thin ceramic sheets. Anywhere from tens to hundreds of these are then pressed together, cut to the proper dimensions and fired. TDK has developed a revolutionary sheet processing method and was first to begin mass producing multilayer ceramic chip capacitors with internal electrodes made of nickel instead of expensive precious metals.

The latter opened the way to the development of lower-cost products with larger capacitance and other outstanding characteristics. In recent times, there has been a switch away from using aluminum electrolytic capacitors and tantalum electrolytic capacitors to multilayer ceramic chip capacitors for large-capacitance capacitors for mobile phones, notebook PCs and other equipment. Electrolytic capacitors have the drawback of generating heat at high signal frequencies due to their high ESR (equivalent series resistance). In multilayer ceramic chip capacitors, however, impedance falls as the signal frequency rises. Furthermore, taking advantage of the fact that it has no polarity it is easier to use. Digital equipment with faster CPUs and lower power consumption will require low ESR decoupling capacitors. TDK has achieved a dramatic reduction in ESR while bringing down the size and increasing the capacitance of capacitors by applying its expertise in materials design technology for dielectric materials and ultra-thin multilayering technologies.

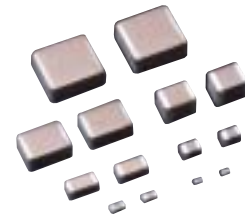
Large numbers of capacitors are being used in automobiles due to advances in car electronics. But extremely severe demands are placed on durability; capacitors must withstand shocks and vibrations and operate under high ambient temperatures. Furthermore, there is a trend toward improving fuel economy by moving the electronic control unit (ECU) closer to the engine and making the wire harness connecting the two shorter and lighter. Responding to these exacting applications, TDK developed an X8R-type multilayer ceramic chip capacitor, which meets the highest standard for temperature resistance. This series of capacitors displays the same superior characteristics in other high-temperature environments as well, such as in precision measurement equipment.

For many years, manufacturers believed that the thickness of the dielectric layers of multilayer ceramic chip capacitors would never fall below 2 micrometers. TDK turned conventional wisdom on its head, however, by developing a superfine ceramic powder with a particle diameter of 0.2 micrometers by applying advanced technology that uniformly combines this powder with a minute quantity of additives. Using these materials technologies and multilayer process technology, TDK has succeeded in developing the 0402-type series (0.4 x 0.2mm) of ultra-compact capacitor. The dielectric layer at present is a mere approximate 1 micrometer thick and capacitors have more than 1,000 layers. Aiming for further breakthroughs, TDK's desire to make progress in multilayer ceramic chip capacitors knows no bounds.

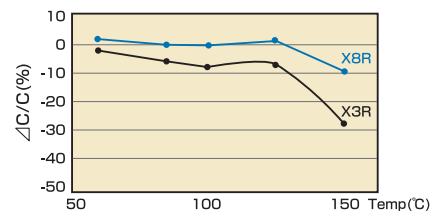


**Cross-section of a multilayer ceramic chip capacitor**

TDK's ability to make smaller, larger capacitance capacitors lies in its proprietary thin film and multilayering technologies. By making dielectric materials finer, TDK has reduced the thickness of dielectric materials and internal electrodes to about 1 micrometer and under 1 micrometer, respectively.



**X8R multilayer ceramic chip capacitor**



**Capacitance Temperature Characteristics**

The permissible variation in capacitance in multilayer ceramic chip capacitors is determined by the temperature range under which each model can be used. This TDK capacitor, the first in the industry to use nickel internal electrodes and designed for high-temperature operating environments, clears X8R, a strict standard under which capacitance cannot vary by more than  $\pm 15\%$  over a temperature range of  $-55\text{--}+150^\circ\text{C}$ .

### Masazumi Arata, Circuit Devices Business Group

*My responsibility is the development of multilayer ferrite coils. Satisfying demands from customers for smaller, thinner coils with enhanced properties while keeping prices low requires us to review existing design and production methods and materials from the ground up. Another important aspect of my work is creating profitable industry-leading products. Speed is key. Development presents its fair share of headaches, but this is outweighed by the pride I take in working on products which customers have high expectations for.*

