TDK's Core Technologies: Materials, Process, and Evaluation & Simulation Technologies

Optical pickup for DVD recorder

DC-DC converter for hybrid electric vehicles

A company's vitality hinges on the ability to constantly become more competitive. And earning the trust of customers is the motivation for refining technologies. Drawing on its collective strengths in three core technological areas—materials, process, and evaluation & simulation technologies—TDK is working to break new ground.

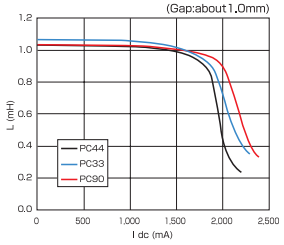
New Products Continue a Tradition of Excellence in Ferrite Technology
Low Core Loss, High Saturation Magnetic Flux Density Products—Just What the Industry Wants

Ferrite is still a material with boundless development potential: even minor changes in material composition and firing conditions can unearth superior characteristics that break new theoretical ground. TDK boasts an unshakeable competitive advantage in ferrite technologies thanks to its extensive know-how as well as sophisticated technological reservoir in this area. No other company can match the experience of TDK, which was the world's first company to commercialize ferrite about 70 years ago.

The importance of ferrite is increasing as a material for cores in transformers and choke coils that today must be smaller and lighter while offering better specifications. In particular, power ferrites require formulations that minimize energy loss within the core so that power supply transformers can operate more efficiently. Generally speaking, however, the sensitivity of ferrite's magnetic properties to changes in temperature has presented obstacles to maintaining a low core loss over a wide temperature range. TDK's PC95 ferrite core material solves this problem. Based on TDK's advanced materials technology, PC95 has won high marks as an ideal material for use in DC-DC converters for hybrid electric vehicles, an application that demands the utmost in energy efficiency. PC95 is also well suited for transformers to power backlights of large-screen LCD TVs, in which the operating temperature of the transformer differs depending on where it is placed in the LCD.

PC90 also continues TDK's tradition of leveraging its knowledge of ferrite to shatter conventional wisdom. For years, formulating a ferrite with both a low energy loss and high saturation flux density was believed to be impossible. TDK developed PC90 by pushing the properties of ferrite to the limit, achieving the optimal balance between these conflicting properties. Achieving both low energy loss and high saturation flux density in one material, PC90 is a long-awaited breakthrough for the industry. DNW45, a ferrite material designed for pulse transformers required by next-generation high-speed LAN systems, as well as increasingly popular ADSL and gigabit Ethernet systems, also illustrates how TDK's rich lineup of ferrites helps customers develop products that are smaller, lighter and more slender while packing in more sophisticated functions.

Transformer cores using power ferrite
TDK's transformer cores are smaller and more slender thanks to original profiles made possible by technology for the design of optimal magnetic circuitry.



D.C. pre-magnetization curve
The D.C. pre-magnetization curve is a critical parameter in making cores smaller without sacrificing performance. It is much better in PC90 ferrite than in TDK's PC33 and PC44. A groundbreaking ferrite, PC90 responds to an electronics industry requiring transformers and coils with a low core loss and high saturation magnetic flux density.

TDK's Magnet Technologies Continue to Break New Ground

Magnets are essential components of electric motors and many other widely used electrical and electronic devices. Progress in magnet technology through the years has made enormous contributions to conserving energy and protecting the environment. Beginning with the commercialization of ferrite magnets in 1959, TDK has consistently been a leader in state-of-the-art magnet technologies. Innovations have included REC rare-earth magnets, made of samarium and cobalt (Sm_2Co_{17}); and the NEOREC magnet, a neodymium (Nd-Fe-B) magnet with a maximum energy product (BH) that is one of the highest in the world. Innovation even includes ferrite magnets, a sector widely regarded as having reached its technological limit. But TDK proved this thinking wrong with its considerable R&D resources and spirit of taking on new challenges. The development of a high-performance lanthanum-cobalt ferrite magnet, a world first, typifies this spirit. Currently, TDK is rapidly stepping up the output of NEOREC magnets as the need for smaller, lighter weight electronic appliances with better performance grows. NEOREC magnets are being used in drive motors in hybrid electric cars, air-conditioner and other home appliance motors, and digital still camera actuators. Use continues to expand.

NEOREC magnets are also indispensable for VCMs (voice coil motors) that move the magnetic heads in HDDs at high speed. Now that HDDs are beginning to appear in mobile equipment, a higher degree of dimensional accuracy is required in magnets for VCMs. No problem for TDK. The company has developed high-precision molding technologies and surface processing technologies that create an extremely uniform plating layer, backed by the development of high-performance presses and exclusive electroplating fluids.

VCM magnets

Fumitaka Baba, Materials R&D Center

Raising production output of rare-earth magnetic materials without undermining their properties is a delicate balancing act. But solving these conflicting issues can lead to cost savings for TDK. It's a very rewarding field of research. I enjoy the challenge, knowing the potential payoffs for the company. Every breakthrough motivates me to achieve more.

Leveraging analysis and control techniques that transcend conventional theory, and by rationalizing its production line and optimizing the procurement of raw materials, TDK is engaged in an endless pursuit of world-leading magnet performance and cost competitiveness. TDK's magnets and the products that use them respond to all manner of cutting-edge needs.

Process Technologies

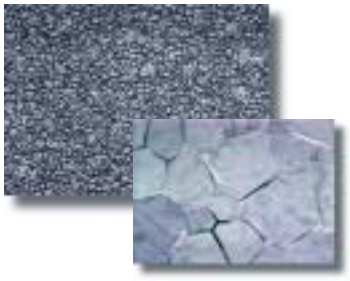
The World's Smallest SMD Inductors—A Showcase of Elemental Technologies

SMD (surface mount device) components have driven advances in the density of circuit boards in mobile phones, video cameras, digital still cameras, MD players and other mobile equipment. SMD inductors, passive components that are every bit as vital as capacitors, must be smaller, slimmer and lighter to facilitate higher circuit densities. TDK offers a range of inductors to respond to such demands. These include the VLF series of SMD power inductors for use in DC-DC converters; the MLK0603 series of multilayer chip inductors, which are used in RF matching circuits; and the GLF SMD inductor series, which has a coil structure with a low DC resistance, thus responding to the trend toward lower power consumption in mobile equipment.

Besides using fine multilayering technology, coil structure-type inductors also employ sophisticated process technologies. The GLF1608, the world's smallest* SMD inductor with a coil structure, was developed by applying several advanced elemental technologies, including technology for creating finer materials to raise the core's dimensional accuracy, precise positional control of each strand of wire and a technique that connects wires at high temperature without using solder. In terms of compactness and the two main characteristics of inductors—inductance and low DC resistance—the GLF1608 series has passed stringent reliability trials with flying colors.

*As of April 2004 (TDK survey)

The GLF1608 series of SMD inductors
The GLF1608 is the world's smallest* SMD inductor with a coil structure. The simple shape reduces materials, compared with the existing NLV series. And TDK has enhanced performance in many ways, such as by incorporating ferrite powder in the resin used for the exterior package.



Microscopic crystal structure
With these ferrite crystals, which are remarkably fine and uniform compared with other formulations, TDK has achieved stable varistor characteristics and miniaturization.

While enhancing competitiveness by reducing costs and shortening lead times and pursuing the highest-quality products free of defects, TDK will continue developing inductors with better performance and smaller dimensions to expand its lineup of SMD inductors.

Demand for Varistors Rising as IC Drive Voltages Fall

Voltages to drive ICs are declining as electronic components become smaller and circuit density increases. And lower voltages are making mobile phones and other mobile equipment more susceptible to surges in voltage from static electricity and other sources. Varistors absorb these surges, protecting equipment from malfunctions and damage. This is done by utilizing the unique physical properties of the boundaries between crystals in the electronic ferrite used in varistors. The three-dimensional matrix formed by these boundaries ordinarily has a high electrical resistance. But when there is a voltage surge, the quantum tunneling effect quickly grounds the current.

TDK's multilayer chip varistors significantly lower the varistor voltage, compared with existing disk-type varistors, and achieve both a more compact size and greater reliability. The application of a proprietary composition of zinc oxide and praseodymium oxide compound and advanced molecular structure control technology has enabled TDK to attain uniformity in the boundaries between ferrite crystals and minimize the size of the crystals. Together with the use of thinner layers of materials, TDK has successfully developed varistors with stable characteristics.

TDK's multilayer chip varistors are effective at combating surges in mobile phones, PDAs, portable AV equipment, game consoles and other equipment. TDK is working steadily to bolster its product lineup, including low capacitance varistors that are suitable for high-speed signal lines such as USB 2.0 as well as varistors that are smaller and compatible with lower voltages and arrays.

Welcome to nanotechnology. This technician examines and analyzes materials in a world few can see.

A team of researchers decked out in their cleanroom suits.

Evaluation & Simulation Technologies

TDK's New Solutions for the Ubiquitous Age

With the start in December 2003 of terrestrial digital TV broadcasts in Japan, HDMI will likely be an acronym viewers become more familiar with. Why? Because HDMI, or High-Definition Multimedia Interface, is an interface that connects DVD recorders, digital tuners and other digital AV equipment to digital TVs. HDMI is a specification that adds functions to AV equipment while maintaining backward compatibility with DVI (Digital Visual Interface), which is used mainly in PC monitors. The defining feature of HDMI is its simplicity—it combines high-definition video and multi-channel audio simply with one small connector.

With HDMI, which employs a differential signaling, filter technology is crucial for preventing skew caused by phase shifts in the differential signal. For HDMI to become the standard interface for connecting different types of digital equipment, it will require the support of as many companies as possible. TDK was the first EMC parts manufacturer in the industry to be registered with HDMI Licensing, LLC, the standardization body for HDMI.

Proposing optimal circuit structures in collaboration with manufacturers of finished products, ICs, connectors and other products represents a new business model for TDK, one that will transform the company into a total provider of EMC solutions. TDK has already seen one result of this initiative with the development of its ACM2012H-900, a common-mode filter for HDMI.

Armed with its evaluation & simulation technologies, which include high-frequency differential signal evaluation technology and IC evaluation technology as well as filter and circuit design technologies, TDK is determined to play a major role in advancing next-generation digital networks.

The ACM2012H-900 common-mode filter for HDMI

Leveraging molding technologies for precisely forming miniature cores and automated winding and wire connection technologies that precisely control the distance between wires, TDK has achieved a superior coupling coefficient. The ACM2012H-900 common-mode filter dramatically extends the transmission band to 6GHz, well above the previous limit of 1.6GHz.

World-Leading UWB Evaluation System

UWB (Ultra Wideband) communications is attracting worldwide interest as an ultra-high speed short-distance wireless communications system with a maximum transmission speed of 480Mbps. UWB enables digital TVs, HDD/DVD recorders, PCs and other equipment to be wirelessly networked to facilitate the instantaneous exchange of large volumes of data such as Hi-Vision video. Expectations are huge for this technology because it is also suitable for positioning measuring and as a short-distance radar. There are many possible applications, from crime-prevention systems and wireless tags to metal detection and resource prospecting.

TDK has participated in MBOA (Multiband OFDM Alliance), the group which is proposing UWB technical specifications, from an early stage. While forging collaborative relationships with other companies in the industry, TDK is mustering its technologies to nurture what it sees as a promising market.

Unlike conventional wireless communications, which uses electromagnetic waves to carry signals, UWB sends and receives data over a wide spectrum of 3.1 to 10.6 gigahertz by using very small pulses of 1 nanosecond in duration. Practical application of this technology, however, requires solutions to problems relating to interference with existing wireless communications systems and other electronic equipment. Furthermore, because the strength of UWB electromagnetic waves is weaker than the noise (interference) emitted by PCs, an extremely high level of re-productivity will be required to conduct evaluation tests.

But UWB communications is seen in some quarters as opening the way to a full-fledged ubiquitous networked society. TDK's evaluation & simulation technologies are a powerful ally for this technology. TDK has developed a UWB evaluation system—the world's first—based on its unique EMC evaluation technology as well as expertise in electromagnetic wave absorption and anechoic chambers. In addition to performing EMC evaluations of UWB communications and antennas, the system can perform measurements of antenna-equipped UWB modules.

Antenna

Anechoic chamber

UWB evaluation system

TDK's UWB evaluation system consists totally of software and hardware developed in-house, including high-performance standard antennas that automatically switch between vertically and horizontally polarized waves, rotating machine devices, controllers, anechoic chambers and control programs.

Yuki Miyamoto, Advanced Process Technology Center

TDK is researching ways to make ceramic substrates as smooth as silicon substrates. It's an exciting research theme because it harbors the potential to widen applications for ceramic substrates. We've already enjoyed some success and we remain convinced that by solving certain technical issues an even higher degree of smoothness will be possible.