



Special Feature: Nanotech & Thin Film Solutions

# Nanotechnology and thin film technology from TDK exemplified by magnetic heads lead the way towards further innovation.

**TDK has world-leading nano- and thin-film technologies. By integrating these cutting-edge technologies with various core competences, TDK is creating new technologies that provide exciting new solutions for our lives.**

**Q&A** TDK Nanotechnology and Thin-Film Innovation | P02

**innovation**  
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BAW Filter | P03

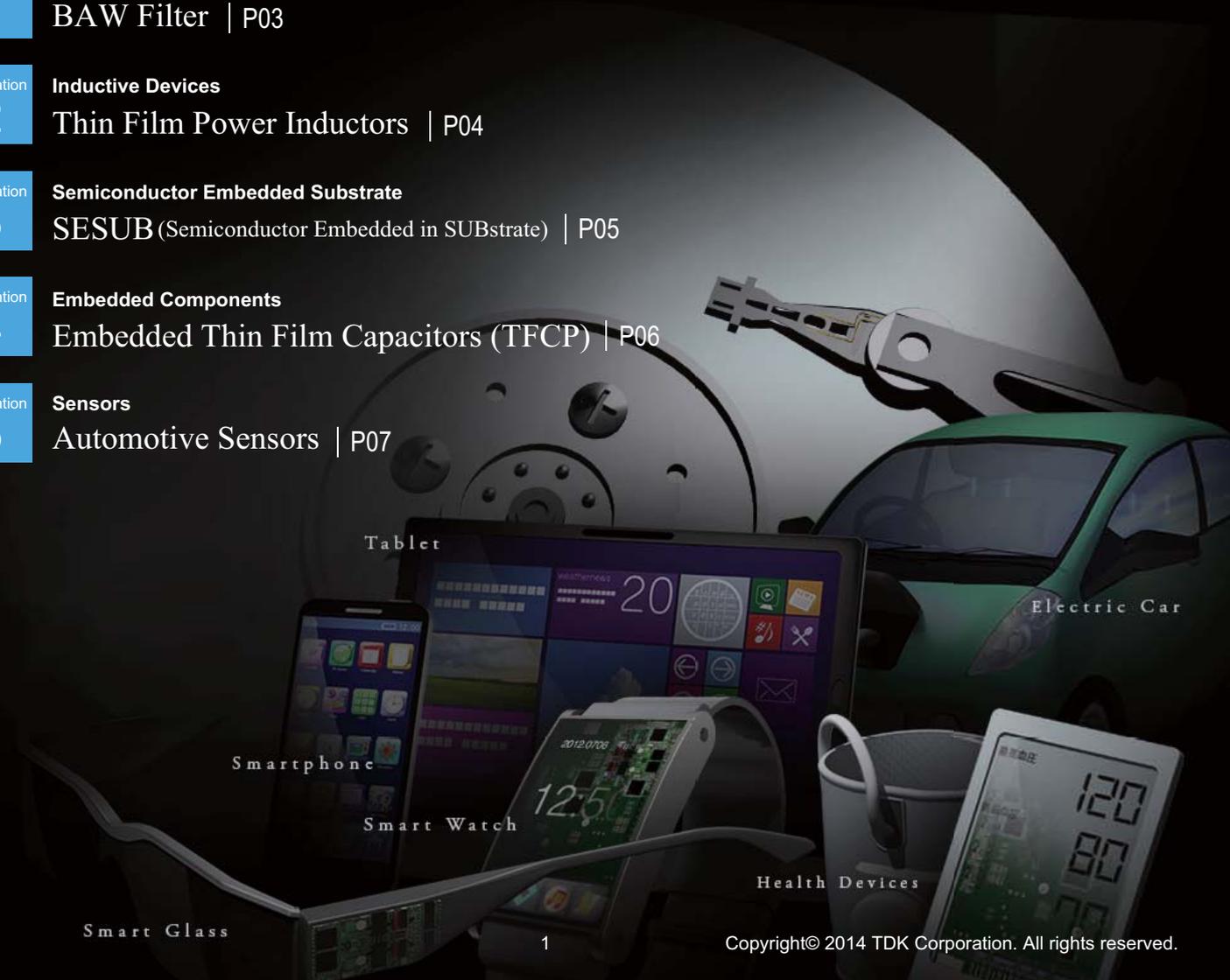
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Smart Glass



Q1

What is amazing about TDK's nanotechnology and thin-film technologies?

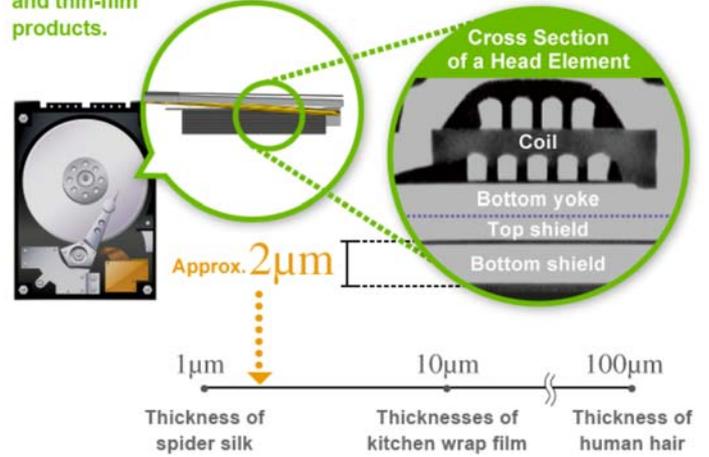
A1

The TDK nanotechnology and thin-film technologies developed through HDD magnetic heads is world-leading technology.

TDK has been the world leader in the HDD magnetic head field. As a result of industry consolidation, TDK has become the only specialized magnetic head maker, and this too is proof of the superiority of its technology. TDK's magnet heads make use of nanotechnologies and thin films just 2 μm thick. This technology is used to form multiple thin layers measured in microns or sub-microns on the surface of materials similar to semiconductor manufacturing processes. TDK has provided more than 7 billion high-quality, thin-film heads to the world. These high-precision thin-film technologies are truly at the world's highest levels.

TDK applies the nanotechnologies and thin-film technologies that it developed through HDD magnetic heads in electronic materials such as capacitor materials, metal magnetic materials, and RF components. As a part of its efforts to reinforce these technologies even further, TDK established the Thin-Film Device Center in November 2013 and is working on new innovations.

HDD heads are representative of TDK's nanotechnologies and thin-film products.



Q2

What are the application areas of TDK's nanotechnologies and thin-film technologies?

A2

Applications are expected in ICT devices such as wearable terminals as well as eco-cars, energy, healthcare, and more.

Wearable devices are expected to undergo rapid advances to a degree that the 2020 Tokyo Olympics are referred to as the wearable Olympics.

TDK will actively develop its nanotechnology and thin-film solutions into priority markets for ICT\* devices such as wearable terminals as well as eco-cars, energy, and healthcare.

\* Information and Communication Technology

TDK has proprietary basic technology and will use its strengths in nanotechnology and thin-film products!



**Global Market Forecast for Nanotechnology Products**

■ Nanomaterials ■ Nanotools ■ Nanodevices



Source: BCC Research, "Nanotechnology: A Realistic Market Assessment"

innovation **1**  
**RF Components**

The shift towards multi-band operation and widespread adoption of LTE is boosting demand for miniaturized low-profile RF components and modules.

The transmitter and receiver circuitry in a smartphone or similar device uses a large number of RF components. BAW (Bulk Acoustic Wave) filters are RF filters that employ a thin film of piezoelectric material and offer outstanding RF bandwidth characteristics, especially for the TD-LTE\* telecommunication standard that is fast gaining acceptance in China and elsewhere. At a time when miniaturization is increasingly demanded, high-quality RF components compatible with the 4G era are needed.

\* Time Division Long Term Evolution



**BAW Filter Market Forecast**

- BAW (Bulk Acoustic Wave) filter
- SAW (Surface Acoustic Wave) filter



Source: Navian Inc.'s report

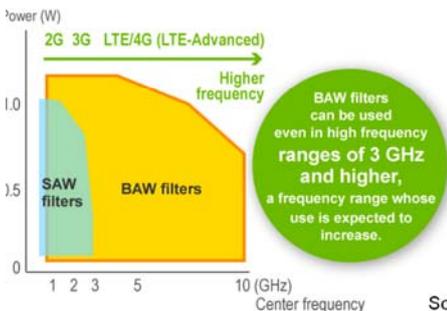
In response,  
 TDK ...

**BAW Filter**

Revolutionary thin-film packaging (TFP) makes possible ultra-compact, ultra-low-profile, RF components and modules.

TDK established revolutionary thin-film packaging (TFP) technology that uses thin film and MEMS technologies and uses it to provide advanced RF components and modules for full-fledged 4G era mobile terminals. TDK also supplies BAW filters, demand for which is expected to grow, and ultra-low-profile SAW/BAW duplexers comprising SAW filters, as well as RF modules and more.

**Applicable Frequencies for SAW Filters and BAW Filters**



Source: TDK materials



innovation **2**

**Inductive Devices**

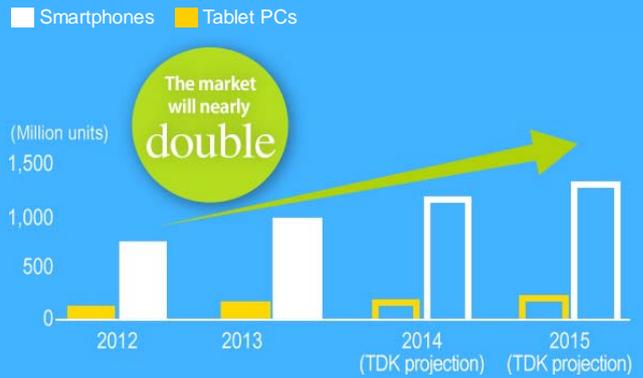
Demands are being made for mobile devices to be smaller and thinner, offer multiple functions, and consume less power.

The market for mobile devices including smartphones, tablet PCs, and ultrabooks is expected to grow substantially in the future.

Technological breakthroughs are needed, and in addition to smaller and thinner devices with multiple functions, battery lives must be extended by reducing power consumption.



**Market Forecast for Smartphones and Tablet PCs**



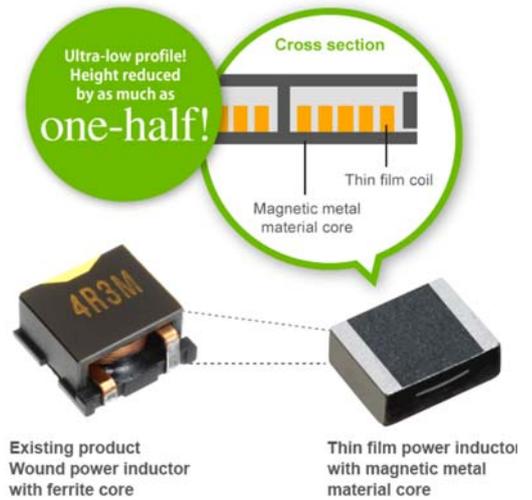
Source: TDK Materials



**Thin Film Power Inductors**

High-precision thin film coil patterning results in lower losses. TDK is achieving reduced power supply space requirements and lower power consumption.

Smartphones and other mobile devices incorporate multiple miniaturized power supplies with power inductors as key components. Thin film inductors from TDK feature a core made of magnetic metal material and employ techniques such as wafer processes and advanced plating technology to create a highly-precise thin film coil. High current support, low loss, and a small footprint and low insertion height make the products ideal for use as power supply modules in mobile terminals.



innovation **3**

**Semiconductor Embedded Substrate**

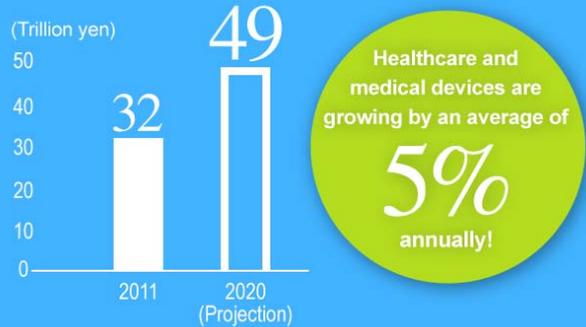
Wearable terminals, health care devices, and similar products require circuit boards with even more functions and more efficient space-saving designs.

The Internet of Things (IoT) that links various devices and terminals to the Internet has lately attracted considerable attention. For example, smartphones and healthcare devices can be linked wirelessly to transmit data to family in a remote location or a doctor in a hospital, and wearing smart glasses enables a user to link to map information and obtain directions to a destination.

Smaller and space-saving designs are an urgent issue for circuit boards, typified by those used in wearable devices.



**Global Market Forecast for Healthcare and Medical Devices**



Source: JEITA materials

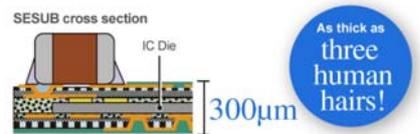
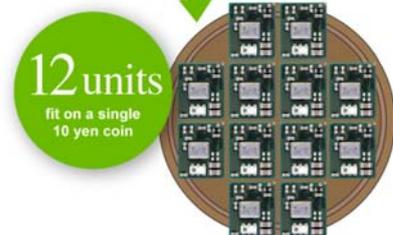
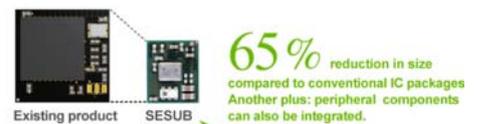
In response, TDK ...

**SESUB (Semiconductor Embedded in SUBstrate)**

An advanced solution that involves embedding IC chips in the substrate. The result is highly-miniaturized modules with superior functionality and high integration.

Embedding integrated circuit chips whose profile has been lowered to several tens of microns into a substrate creates a four-layer board with a thickness of a mere 300 microns. Excellent noise suppression and thermal dissipation enhance the degree of design freedom. High-performance modules with small dimensions and outstanding characteristics can be created.

The range of possible applications includes power management units (PMU) for smartphones, wearable devices such as smart watches and smart glasses, and healthcare devices including blood oxygen densitometers. The technology is also optimal for fitness devices such as wristband type activity trackers.



\* The thickness of a human hair is about 80 µm to 100 µm.



**Bluetooth modules**

**Compact, low-profile, low energy consumption.**

Low-noise DC-DC converters and Bluetooth modules with communications functions have also been successfully developed.

innovation **4**

**Embedded Components**

Technology for embedding electronic components in circuit boards to make breakthroughs in the limits of mounting density is attracting attention.

With the appearance of various wearable terminals including smart watches, smart glasses, and accessory-type communications terminals, conventional methods of making electronic components smaller and thinner are approaching the limits where further miniaturization will be difficult. As a result, technologies for embedding electronic components in circuit boards rather than mounting the components on the board as in the past are entering the limelight.



**Global Market for Smart Glasses and Smart Watches**



The market is growing

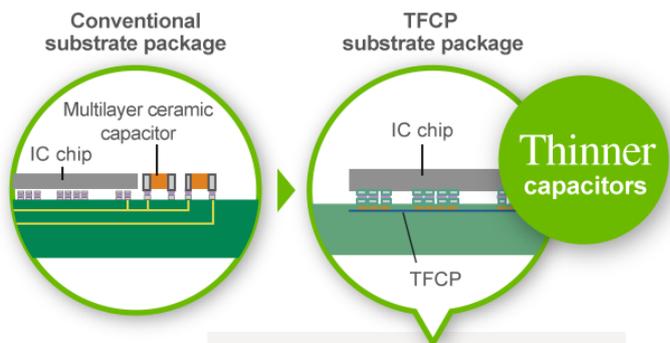
Source: Yano Research Institute Ltd., "2013 Smartphone-Linked Service and Device Market Outlook"



**Embedded Thin Film Capacitors (TFCP)**

**TDK develops a completely novel type of capacitor!  
Ultra-thin and flexible.**

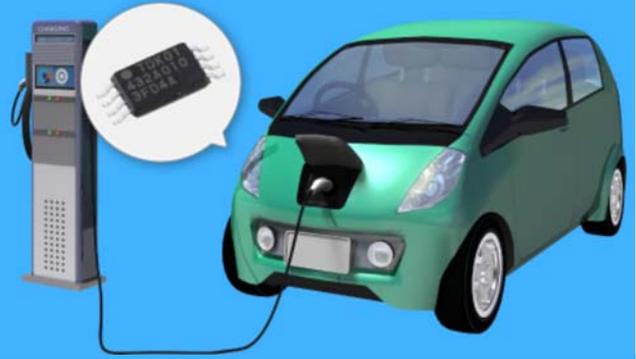
TDK developed a new type of capacitor that uses a dielectric film vapor-deposited on nickel foil, made possible by the application of cutting-edge sputtering techniques usually employed for manufacturing HDD heads. Extremely thin dimensions allow embedding in the IC package substrate, resulting in a drastically reduced mounting footprint. As the entire product is flexible and can be freely shaped, it lends itself to new applications and is ideal for designing compact modules for the next generation of ICT devices such as the wearable terminals now on the horizon.



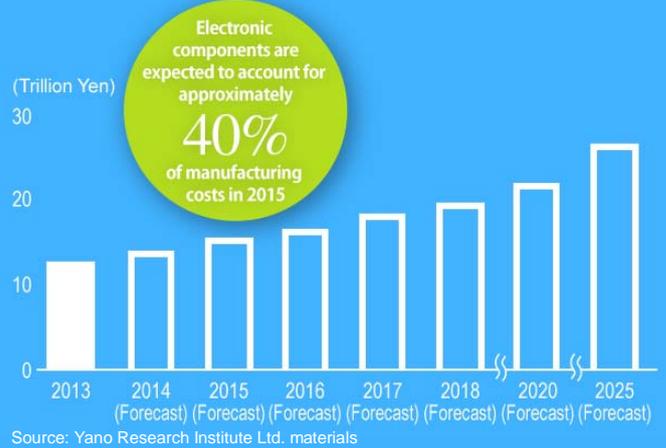
innovation **5**  
Sensors

The roles of automotive sensors are becoming ever more important for developing safe, secure, comfortable, and environmentally-friendly eco-cars.

Automobiles are equipped with various sensors. For example, sensors provide advanced control of engines and motors according to the vehicle status to provide safe, comfortable, and low-energy driving. Achieving this requires more precise sensors.



Market Forecast for Automotive Electronic Components and Systems



In response, TDK ...

Automotive Sensors

High-accuracy sensors using TMR elements from HDD heads contribute to further improved fuel efficiency in eco-cars.

TDK supplies various sensors optimized for automotive applications such as TMR angle sensors that use TMR elements from HDD heads, electric current sensors, and temperature sensors.

TDK's TMR angle sensors are manufactured by means of highly advanced thin-film process technology similar to methods used in semiconductor manufacturing. The products are used as high-precision gear tooth sensors that detect the rotation speed and position of gears attached to engines and motors, angle sensors for electronic power steering (EPS) motors, and angle sensors that accurately detect the angle of the steering wheel. TDK supports further improvements in the fuel efficiency of eco-cars as well as safe and comfortable driving.

