BiCS FLASH 3D Flash Memory Fabricated Using 48-Layer Process Technology

Toshiba commenced the shipment of samples of the BiCS FLASH three-dimensional (3D) 128 Gbit-per-chip flash memory in March 2015. These samples are based on a 2-bit-per-cell (multilevel-cell (MLC)) technology and are fabricated using a 48-layer stacking process in collaboration with SanDisk Corporation. Compared with the conventional two-dimensional (2D) floating-gate flash memory, BiCS FLASH is designed to achieve faster speed, lower power consumption, and higher reliability due to reduced adjacent cell interference.

We also began shipping samples of a 48-layer 256 Gbit-per-chip 3-bit-per-cell (triple-level-cell (TLC)) BiCS FLASH, which provides double the storage capacity of the 2D floating-gate type, in September 2015.

We will continue to increase the flash capacity to meet demand in the rapidly growing storage market, and will replace our existing 2D floating-gate flash memory products with the 256 Gbit-per-chip BiCS FLASH in stages.

To fulfill the needs of the market, we intend to pursue further development of leading-edge technologies while also enhancing our productivity and competitiveness.

BiCS FLASH 3D flash memory fabricated using 48-layer stacking process

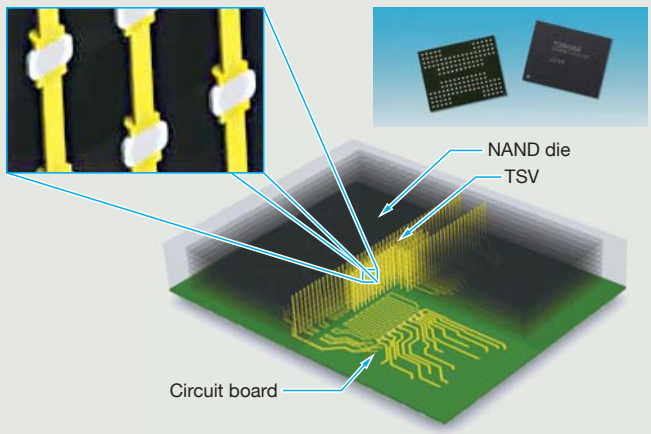
World's First NAND Flash Memory with up to 16 Stacked Layers Fabricated Using TSV Technology

NAND flash memory has become widely used in enterprise storage applications in recent years. In August 2015, Toshiba announced the development of the world's first 8- and 16-die stacked NAND flash memory products using through-silicon via (TSV) technology(*), in order to provide a solution for market requirements such as high speed and low power consumption.

This TSV technology utilizes vertical vias to interconnect multiple silicon dies in a single package. It provides double the data transfer rate of the previous technology and reduces power consumption during read and write operations by half.

We are planning to apply the TSV technology to our BiCS FLASH 3D flash memory.

(*) As of August 2015 (as researched by Toshiba)



Flash memory package using TSV technology

SSD with Random Read Performance of 270 k IOPS for Enterprise Use

Toshiba commercialized the PX04 family of solid-state drives (SSDs) with a Serial Attached SCSI (Small Computer System Interface) (SAS) interface for enterprise use in August 2015. Incorporating a system-on-a-chip (SoC) designed by us, the PX04S family achieved the industry's highest-level sustained 4 Kbyte random read performance of 270 k input/output operations per second (IOPS)(*1) and the industry's highest-class capacity of 3.84 Tbytes(*2), (*3).

The PX04S family consists of four enterprise series: the high-endurance PX04SH series with a write endurance of 25 drive writes per day (DWPD)(*4), the mid-endurance PX04SM series with a write endurance of 10 DWPD, the enterprise value PX04SV series with a write endurance of 3 DWPD, and the read-intensive PX04SR series optimized for applications requiring 1 DWPD that mainly consist of read and sequential write operations.

SSD with random read performance of 270 k IOPS for enterprise use

(*1) As of August 2015 for 2.5-inch enterprise SAS SSDs (as researched by Toshiba)

(*2) As of August 2015 for 2.5-inch enterprise 12 Gbit/s SAS SSDs (as researched by Toshiba)

(*3) Definition of capacity: Toshiba defines a terabyte (Tbyte) as 10^{12} (1 000 000 000 000) bytes.

(*4) One full drive write per day means that the drive can be written and rewritten to its full capacity once a day every day for the warranty period.

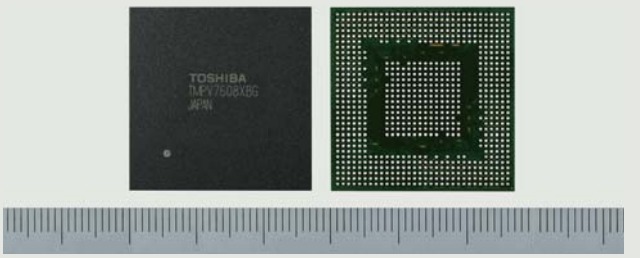
TMPV7608XBG Image Recognition Processor for Automotive Applications

The TMPV7608XBG image recognition processor supports standard advanced driver assistance system (ADAS) applications, including autonomous emergency braking (AEB), traffic sign recognition (TSR), lane departure warning (LDW), lane keeping assist (LKA), high beam assistance (HBA), and forward collision warning (FCW), as well as upcoming applications such as traffic light recognition (TLR) and nighttime AEB car-to-pedestrian crash avoidance that will become part of the European New Car Assessment Programme (Euro NCAP) in 2018.

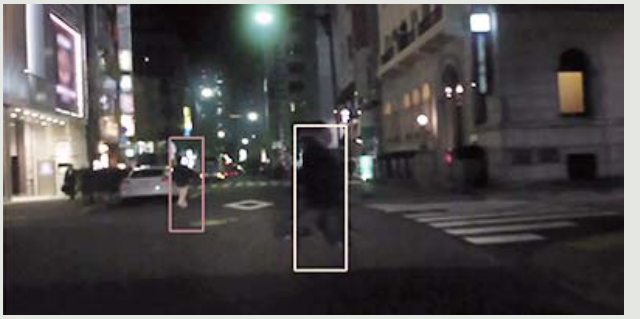
The TMPV7608XBG incorporates Toshiba's unique technology for using color-based image information to improve recognition accuracy, especially at nighttime. In addition, the TMPV7608XBG provides a structure from motion (SfM) accelerator that realizes 3D reconstruction using an input image stream from a monocular camera.

The TMPV7608XBG incorporates eight new image processing engines and various image processing accelerators, numbering 14 in all, to achieve 10 times the image processing performance of the conventional product(*).

(*) Compared with Toshiba's previous model. As of February 2016 (as researched by Toshiba)



TMPV7608XBG image recognition processor for automotive applications



Detection of pedestrians at night

TaRF8 SOI Process for RF Switches Achieving Industry's Lowest-Level Insertion Loss

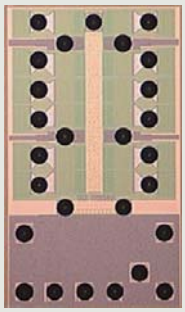
Toshiba developed the TaRF8 process, a next-generation TarfSOI (Toshiba advanced RF SOI) process using a silicon-on-insulator complementary metal-oxide semiconductor (SOI-CMOS) technology(*1) in November 2015. Our radio-frequency (RF) switch integrated circuits (ICs) fabricated using the TaRF8 process deliver the industry's lowest-level insertion loss(*2).

In recent years, demand has risen for multiport RF switch ICs with higher performance to accommodate the increasing data transfer rates in mobile communications. Our single-pole 12-throw (SP12T) RF switch fabricated using the TaRF8 process has achieved a 0.32 dB insertion loss at 2.69 GHz, an improvement of 0.1 dB compared with products fabricated using the current TaRF6 process. The new RF switch helps to decrease RF transmission power loss, leading to longer battery life for mobile devices.

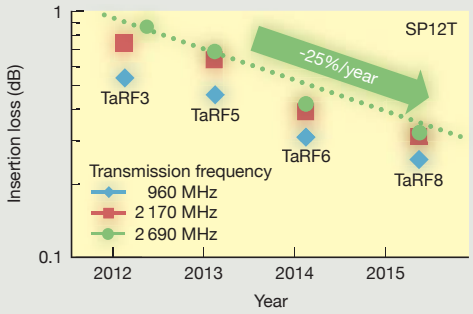
As an integrated device manufacturer, we are engaged in both product and manufacturing process development in our own manufacturing facilities. Therefore, we can quickly apply the latest process technology to new products. We will continue to improve the performance of our TarfSOI process technology to meet the market demand for RF switch ICs.

(*1) A technology to reduce parasitic capacitance by using an insulation layer under the channel of a MOS field-effect transistor (MOSFET)

(*2) As of November 2015 in the RF switch IC market (as researched by Toshiba)



SP12T RF antenna switch IC



Improvements in insertion loss characteristics

"Environment Sensing Logger" Using ApP Lite TZ1000 Processor Providing IoT Solution

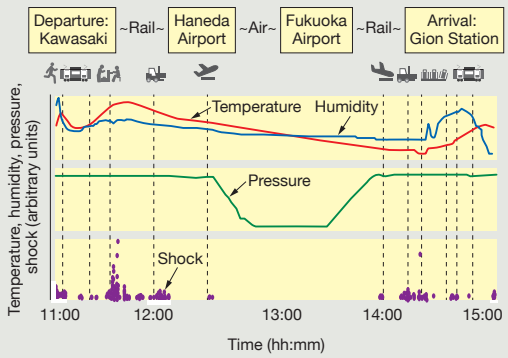
Damage resulting from transportation in the global logistics market, whose scale reaches approximately 150 trillion Japanese yen per year, is estimated to total 4 trillion yen. Improving the quality of logistics is therefore a significant issue.

To address this issue, Toshiba developed an "environment sensing logger" providing a new Internet of Things (IoT) solution for logistics equipped with the ApP Lite TZ1000 processor, which features various sensing functions and low power consumption, in June 2015. The TZ1000 allows simultaneous sensing of five types of environmental data (temperature, humidity, pressure, illuminance, and shock). Its battery lasts about two months on a full charge. In addition, the TZ1000 provides secure data collection using an integrated security engine.

This environment sensing logger is compliant with the IP67(*) ratings for dust and water ingress and the U.S. military standard drop tolerance requirements (MIL-STD-810). Therefore, it provides stable sensing even under harsh conditions during transportation. The graph shows data collected by the environment sensing logger during transportation from Kawasaki Station to Gion Station, including a flight from Haneda Airport to Fukuoka Airport. The combination of several types of data provides a more accurate indication of the environmental exposure of goods.

The environment sensing logger helps to identify any problems along the transportation route and thus contributes to the management and improvement of transportation quality.

Environment sensing logger



Example of log data of baggage shipped by air from Haneda to Fukuoka

(*) Degree of protection provided by enclosures (IP Code) stipulated by Japanese Industrial Standard (JIS) C 0920

Desktop Electrolyzed Functional Water Generator

Hypochlorous acid water has high antibacterial and deodorizing properties. It is rapidly effective against a wide range of bacteria and viruses, including influenza and noroviruses, safe for animals and plants, and has no harmful or residual effects. Hypochlorous acid water is therefore approved as a food additive for the sterilization of foods and is also effective as a deodorizer for neutralizing certain types of odors.

Toshiba has released the EWP-001 desktop electrolyzed functional water generator, which simplifies the generation of hypochlorous acid water. It is light, compact, and portable, and can produce one liter of weakly acidic hypochlorous acid water in three minutes by electrolyzing water and salt. (The available chlorine concentration, ACC, is approximately 30 mg/kg.)

The EWP-001 is ideally suited to small and medium-scale facilities such as clinics and day-care centers to generate hypochlorous acid water for gargling, hand washing, and the sterilization of food and equipment. It can also be used on a trial basis at factories and farms before introducing large generators.

The EWP-001 is expected to find a wide range of uses in hygiene management.

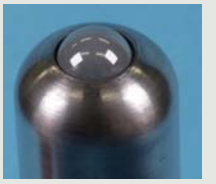
EWP-001 desktop electrolyzed functional water generator

Silicon Nitride Tool for Friction Stir Welding

Friction stir welding (FSW) is a new joining process that uses friction heat generated between a rotating tool and material, which causes the material to soften. The tool then mechanically intermixes two pieces of metal at the joint so that the softened metal can be joined by mechanical pressure. This new process provides higher joint strength than the conventional joining process. Furthermore, it allows different materials to be joined.

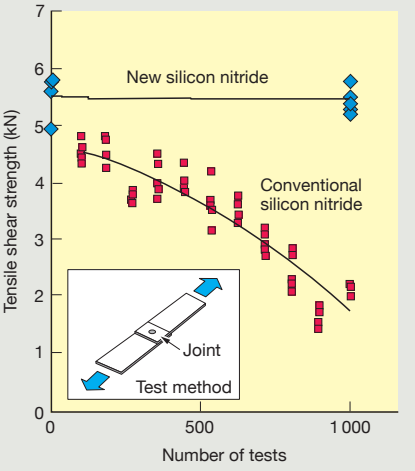
FSW has been commercially employed to join various materials with low melting points such as aluminum floorboards for rolling stock. However, FSW has not gained wide uptake for steel and other high-melting-point materials because conventional FSW tools do not endure high temperatures and heavy loads and their cost is high.

Toshiba Materials Co., Ltd. has developed a new silicon nitride FSW tool with improved mechanical properties and high-temperature endurance using a microstructure controlling technology. In order to realize the practical application of this tool, we are currently working to improve its high-temperature wear resistance in collaboration with the Hiroshima Prefectural Technology Research Institute and the Joining and Welding Research Institute of Osaka University.



Tool for friction stir spot welding

Tool for friction stir welding



Tensile shear strength of steel plate cold-rolled commercial grade (SPCC) double-layer joint using friction stir welding with silicon nitride tool