TOSHIBA
Leading Innovation

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Frequently Asked Questions about Toshiba Fuel Cell Technology

1. **What is a Direct Methanol Fuel Cell?**

   A fuel cell is an electrochemical device that converts the chemical energy of fuel, such as methanol, into electric energy. Unlike batteries, which require recharging, fuel cells can continuously produce electricity as long as there is a constant fuel supply. Direct Methanol Fuel Cells (DMFC) can provide a new energy concept for personal electronic devices such as notebook PCs, cellular phones or wearable electronic devices like digital audio players and headsets.

2. **When did Toshiba begin research on direct methanol fuel cells? What are some of Toshiba's notable achievements and milestones in this field?**

   Toshiba has conducted R&D on both active and passive fuel cells since the early 1990s, and has filed and obtained many patents on DMFC technology. Its achievements confirm that the company remains in the forefront in developing the potential of fuel cells.

   Toshiba led the industry by demonstrating the first DMFC for portable PCs in March 2003. In June 2004, Toshiba announced a prototype of the world's smallest DMFC with energy output of 100 milliwatts (mW), which could be integrated into devices as small as digital audio players and wireless headsets for mobile phones. This new device adopted a "passive" fuel supply system which fed methanol directly into the cell. In 2005, Guinness World Records certified this achievement. In October 2005, Toshiba exhibited a portable battery charger and cell phone jointly developed with KDDI and demonstrated conceptual products, such as a portable music player, at the CEATEC Japan trade show. In January 2007 at CES, Toshiba exhibited a notebook PC with a smaller, lighter, built-in prototype DMFC unit that realized an average output of 10W or more. By using smaller and thinner parts, Toshiba was able to install the DMFC inside the PC. This prototype is designed to operate for approximately 5 hours from a 70cc cartridge, but operating time could vary depending on the PC applications. In 2008, Toshiba displayed chargers or integrated fuel cells in mobile TV viewer and cell phones at CES and CEATEC.

3. **What is the difference between active and passive DMFC?**

   Active systems use a pump and fan to feed methanol and oxygen into a cell or cell stack, where the oxygen reacts with the methanol to produce electricity. Active systems are more complex than passive systems and are better suited for applications demanding larger power consumption. Toshiba's active fuel cell development for electronics is targeted toward the mobile computing market.

Passive DMFC have a simpler structure that requires no pump and fan. Passive and active fuel cells have different ranges of power output, requiring the devices to be integrated quite differently.

Passive DMFC produces energy around 100mW to 2W and requires no pump and fan, making the fuel cell size much smaller than that of the active type and suitable for use in smaller portable equipment such as cell phones, headsets and digital audio players.

4. What are the target products and markets for passive and active DMFC?

Generally speaking, applications that fall under the umbrella of "mobility and wearability," require passive-type fuel cells. These applications include Bluetooth headsets, cell phones, mobile TV viewers, digital audio players, PDAs and other small handheld electronic devices that require miniaturization. The active type will cover devices such as portable PCs and cordless small home appliances.

5. Why are these fuel cells called "direct"?

DMFCs (both active and passive) use methanol as fuel and do not change the chemical structure of methanol by subtracting hydrogen when feeding the fuel into the cell, thus sending methanol "directly" into the cell.

6. What is Toshiba's advantage over DMFC developed by other companies?

Toshiba developed a system that allows a high concentration of methanol, which had been said to be difficult to overcome. This technology allows methanol to be stored at a much higher concentration, and achieves a much smaller fuel tank than before**.**

7. When will Toshiba commercialize fuel cells?

Toshiba expects DMFC to be integrated into actual products in 2009. The first products will be sold on a limited and regional basis, followed by wider deployment over time.

8. What needs to be done to support the widespread commercialization of DMFC?

Additional development is needed to increase power output, reliability and miniaturization. Availability of methanol fuel cartridges in society and deregulation of methanol fuel cartridge transportation are also key issues.

9. When commercialized, will these devices be cost-competitive with battery-powered devices?

DMFC has specific advantages which are different from the prospects of rechargeable lithium batteries, so it's not easy to compare them simply with the cost of lithium batteries. When DMFC enters mass production, Toshiba will introduce these devices at competitive prices and projects such that sufficient cost performance can be realized to justify their use.

10. Where would someone refill a fuel cell?

Fuel cartridge refills will be available for customers at convenience stores, drug stores, E-commerce and other designated commercial outlets. After customers purchase the cartridge, they can refill the fuel cell by themselves. However, the notebook PC's case is different from other devices. The amount of fuel consumption per single operation is larger, compared to smaller devices, and to facilitate usability, an insert type cartridge has been proposed for the notebook PC. Toshiba is working with the appropriate organizations and regulatory bodies to ensure a timely market adoption, and to consider each country's laws and regulations.

11. There are several sources of fuel under consideration for fuel cells. Why is Toshiba concentrating its research on methanol fuel cells? What are the advantages of methanol as a fuel source?

There are two reasonable choices for power source of portable devices, hydrogen or methanol. Hydrogen requires complicated storage and would take much more space for small devices. Liquid methanol is more practical for small devices, in terms of storage and energy density as fuel. Methanol has 5-10 times the energy density of lithium-ion batteries when compared in the same fuel capacity, enabling the DMFC to deliver much longer continuous operation.

12. How long can a fuel cell operate?

The length of time a fuel cell can operate varies with the size of the fuel tank or cartridge and the power requirements of the mobile electronics devices**.**

13. Is DMFC considered safe?

When used normally and when taking the necessary safety measures into account, the risk is very limited. If abused or misused, there is a possibility of combustion as methanol is a flammable liquid. Compared to batteries, Toshiba expects better safety results since the energy is not stored in the fuel cell. Batteries, on the other hand, hold readily available energy inside, which under abnormal performance conditions such as external shorts, overcharge, or overload may become a safety concern.

14. Do you think methanol will be allowed on airplanes and other secured modes of transportation?

The International Civil Aviation Organization (ICAO) issued in 2007 a Technical Instruction (TI) that allows the transportation and use of methanol fuel cells and methanol fuel cartridges on board passenger airliners effective January 1st, 2007.

Japan has already ratified this exemption, as well as other countries. The US Department of Transportation (DOT) has ratified cartridges that are built into or part of an electronic device, but is still reviewing use of "satellite" cartridges used to refill DMFC devices.

15. Will future mobile devices use both a fuel cell and a battery?

It's possible, as hybrid solutions are quite promising. The final application for a hybrid may depend on the original equipment design, subsequent system level trade-offs and the end user requirements.

16. Are there organizations addressing issues of standardization and compatibility in fuel cells?

The IEC, a multi-national organization that defines industrial standards for electronic devices, consumer products and communications equipment, has established three working groups within its TC105 fuel cell technical committee. The micro fuel cell working groups to consider industrial standards are referred to as WG 8, 9, and 10. These Working Groups are tasked with providing customers and manufacturers with standards for Safety (at WG8), Performance (at WG9), and Interchangeability (at WG10). As for compatibility, by establishing WG10, the IEC has brought together a team of experts on micro fuel cells that will focus on setting common guidelines on specifications for micro fuel cell power units and their fuel cartridges by 2008. A recognized industrial standard for micro fuel cells will provide users of micro fuel cells with easier access to standardized fuel cartridges designed to fit any type of electronic device and produced by manufacturers around the world.

17. What are the environmental benefits for transferring over to fuel cells as a source of energy?

Unlike generators that are powered by engines, fuel cells do not emit harmful materials such as nitrogen oxides or sulfur oxides. And since the electricity is generated by a scientific process, fuel cells do not vibrate or make noise. In addition, one fuel cell cartridge can be reused over-and-over again, whereas batteries need to be replaced.

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