How to sterilise

There are different methods of achieving a sterile product or instrument. The most common way to kill micro-organisms like bacteria, fungi and viruses is by exposure to heat. For medical purposes, autoclaves are widely used. Within an autoclave, objects to be sterilised are exposed to steam at a temperature of around 125°C for a set period of time. The high temperature, humidity and pressure of the steam are real disadvantages of this approach. Some materials cannot withstand these conditions.

For this reason, another method is increasingly applied for sterilisation: Irradiation by gamma or X-rays. This approach offers several advantages. Since gamma rays are highly penetrating, the goods can be disinfected after packaging, within bigger boxes or even on pallets at room temperature. That is to say, the objects are sterilised at the last stage of the production process, and costly high-class clean-room conditions during production might not be necessary.

The irradiation dose depends on the original microbial condition of the goods and the target safety level. Usually it is required to apply a dose of 25kGy to 45kGy - a kiloGray being the Standard International unit of absorbed radiation dose of ionising radiation.

How to track sterilised products

Modern logistic processes use Radio Frequency Identification (RFID) technology to label and track objects. In the simplest form, an electronic RFID tag contains a unique ID, similar to a barcode label. In contrast to the latter, RFID tags can be read contactless, via an air interface without direct optical access to the tag. If several products are packed into a bigger box, it is possible to identify each single object without opening or unpacking the outer box.

Even more important, the electronic RFID labels allow the storage of additional data onto the tags. Data can be written during the manufacturing process (e.g. lot number, manufacturing date, expiry date, product type, etc.) and during the flow through the supply chain (e.g. leaving the factory, date of sterilisation, name of logistic partner, etc.)

For medical instruments and products in particular, it is very important to reliably identify the objects as well as document the treatment and manufacturing history. Mistakes can lead to serious problems and risk for the life of patients.

To leverage these features to the full extent for medical applications, it is necessary to combine the gamma ray irradiation and RFID technologies already mentioned.

Conventional E2PROM based RFID products do not withstand the irradiation process. After exposure to the irradiation, the memory content is erased. At this point, Fujitsu’s FRAM technology comes into play.

FRAM technology

In contrast to the conventional non-volatile memories, Flash and E2PROM, the content of an FRAM cell is not stored in the form of charge carriers in a ‘floating gate’. The information – logically 0 or 1 – is contained in the polarisation of the ferroelectric material lead zirconate titanate, PZT (Pb (Zr,Ti)O3). This material is placed between two electrodes in the form of a thin film, in a similar way to the structure of a capacitor: When an electrical field is applied the material polarises in one direction and retains this structure even after the field has been removed. If the direction of the electrical field is reversed, the atoms polarise accordingly in the opposite direction. An FRAM memory cell has the same structure as a DRAM cell and consists of a transistor and a capacitor; but in this case the FRAM cell contains a capacitor with a ferroelectric dielectric.

The energy, applied during an irradiation process, removes the charge in floating gates of E2PROM cells but does not affect the polarisation of FRAM cells. Scientific studies have proven FRAM’s resistance to irradiation, for doses up to 50kGy.

Further FRAM advantages

FRAM offers further advantages, especially for RFID products. Since no large charge quantities have to be displaced, charge pumps to generate high programming voltages are not necessary. Consequently, FRAM technology is much more energy-saving than E2PROM. This directly affects the operating range of
RFID tags in a positive way. Due to the low power consumption nature of FRAM, the operating range is higher for a given field strength or power density.

FRAM memories can be written as fast as they can be read, i.e. FRAM’s write access is about 25 times faster than E2PROM’s write access. The maximum number of write/delete cycles for Flash and E2PROM is between 10,000 and 100,000. If this limit is exceeded, the memory content can no longer be reliably stored. By comparison with over 10 thousand million write/delete cycles (10^{10}), the lifetime of an FRAM memory is almost unlimited. This allows the re-use of FRAM tags many times over. Occasionally, FRAM is incorrectly associated with ferromagnetism. Magnetic fields do not affect the ferroelectric material.

Summary
Compared to conventional E2PROM/flash based RFID chips, Fujitsu’s FerVID family enables the same high speed data transfer rate for both reading and writing over long distances. The write endurance, specified to 10 billion cycles, is far higher than that of conventional RFID tags, thus saving cost and time in applications.

Fujitsu offers HF and UHF FRAM RFID products. The ISO 15693 compliant devices cover the 13.56MHz operating frequency and feature 2kByte and 256Byte memories respectively. In the UHF band of 860 to 900MHz, Fujitsu offers the 4kByte FRAM device, compliant to the EPC global C1G2 standard. The products feature anti-collision, lump and fast read/write transmission commands.

Furthermore, a dual-interface device is also available in two different types – one as a conventional contactless EPCglobal RFID product and the other as a derivative with an additional contact-based SPI interface. This dual-interface type can be implemented as part of a Microcontroller-based embedded system.

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