

Packaging technology: Security and tamper evidence protection systems

By Huw Kidwell

The protection of pharmaceutical product integrity is important at all levels and the complete security of the supply chain is critical for the manufacturers, research organisations and the end user involved. A compromised pharmaceutical product or API (active pharmaceutical ingredient) is potentially life threatening or injurious and there are some well documented cases such as the problems with fake Gentamicin importation investigated in the US during the 1990's, which caused several deaths, and more recently in early 2009 counterfeit diabetes medication in China, which was responsible for the deaths of at least two patients. The World Health Organization (WHO) currently estimates that up to 10% of the medication sold worldwide is counterfeit [1]. In addition pharmaceutical products, intermediates and APIs can often be temperature, moisture or air sensitive and require continual monitoring both during transport and in storage awaiting use. Proof of their continual integrity in the storage packaging is crucial for regulatory approval and quality control.

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Pharmaceutical security

The security of finished dosage forms, such as tablets and capsules in blister packs and tamper evident containers, has become established in the pharma industry. Measures introduced include: Radio Frequency Identification (RFID) for commonly counterfeited drugs such as Viagra, OxyContin, and the AIDS drug Trizivir; DNA codes for anticancer drugs introduced by Bristol Myers Squibb in 2003; nanoscale trace detection materials for introduction into the drug substance, addition of cryptographic files to the final artwork of the packaging or special packaging inks which are detectable only under specific wavelengths. In addition the US Congress passed a bill requiring all prescription drug packaging to incorporate RFID by 2010 [1].

How to protect bulk containers

In this article we examine what technology and innovation can offer for the security of bulk containers of APIs (active pharmaceutical ingredients) during the manufacturing process. Bulk containers are available in various shapes and sizes and also in different materials, from nestable polymer containers with screw on or snap on lids to bulk steel drums. The choice of container depends on the format of the material being transported, the quantity, the capacity of the container and the

required level of protection and cleanliness or purity. The first level of security is the primary closure where the lid of the container is secured with a band, metal crimped lid, Safe Seal label or shrink sleeve (there



may also be a pull tight security seal securing the lid to the body via a loop in each). This level of security attempts to secure the lid so that it cannot accidentally be taken off or even removed to adulterate the contents without this fact being recognised. This level of security has been superseded in the past and an example of this comes from the food industry where 'bubble top safety' lids have been removed from baby food jars and replaced without apparent noticeable effect. In these cases a shrink sleeve was added and the integrity of the sealed top increased. The pull tight security seal is generally a plastic band similar to a cable

tie (may also be a steel cable), which cannot be opened without cutting the band. These seals may also incorporate sequential numbering or bar codes for added security during audit or receipt. The Safe Seal label uses a multi-layer technology where the adhesive layer secures the lid to the body of the container and any attempt to remove the label/seal will result in tearing or if attempts are made to 'peel it off' a void message being revealed on one of the inner layers.

The second level of security or closure, which may take the form of an inner 'foil' or polymer film adhered to the edge of the container lid, usually has a dual purpose. Firstly the drug material is sealed and contained and will not spill out – this can also ensure that the material is sealed under inert atmosphere and so protected from oxidation or degradation during transport. Secondly, evidence of tampering via this route can be immediately recognised as the seal around the edge has been broken.



The Tylenol crisis in the US was a wake-up call for pharmaceutical and food companies. This prompted the introduction of plastic banding seals around screw lids and also internal foil safety seals to combat any tampering with products.

Having set the closure 'scenarios' for various containers and accepted that the material will not leak out through these

Multiple Layer Security

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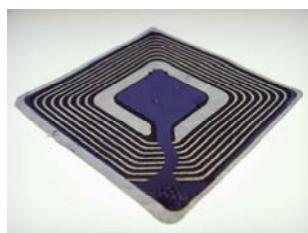
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formable foils or heat-seal coatings. In use the sealing material must be compatible with the material in the container to prevent contamination. In addition, any adhesive must be inert and not contaminate the product. Laminate sealing foils usually have a metal component (aluminium for strength), a barrier component such as EvOH (ethyl vinyl alcohol copolymer), which is impervious to gases and polypropylene for its moisture resistance properties. Some seals may simply use a crimped metal foil moulded over the top of the container without using adhesive. This system has the advantage that no adhesive is used and there is no spring-back of the material when sealing, but the foil could potentially be removed and replaced. However to offer additional protection the foil could be printed with a logo or barcode.

Closure foils incorporate a lot more technology than would be seen at first glance. In most cases if a peelable seal is broken then it should be obvious that the container has been tampered with and the contents adulterated – it is not easy to restore a broken seal. In a refinement to this one major German-based converter produces a plain, metallised foil laminated with a holographic embossed silver security foil that has a totally invisible hidden 'VOID' message which becomes visible if the label is peeled away indicating it has been opened. Some adhesive seals incorporate a dry peel coating over the adhesive layer which makes it impossible to replace the seal once it has been peeled away.

The seals or containers themselves may also include barcode or lot numbers printed using laser etching or indelible ink jet printing on them for additional security against counterfeiting or tampering. This means that simple scanning at either end of the supply chain can compare the inventory to the cargo manifest and actual stock to see if the quantities and identity of the containers tally. This is extremely important in the Good Manufacturing Practice (GMP) for pharmaceutical companies as the purity and provenance of all material components needs to be documented prior to incorporation into the manufacturing process.

Often multiple 'layers' of security or redundant indicators may be used in packaging because no single layer or device is 'tamper-proof' and the multi-system makes counterfeiting or tampering much more difficult.



RFID is a technology that has been adopted/tested with great enthusiasm by a number of multinational companies with large logistic commitments. Much more information can be stored using RFID 'chips' but security of this information is an issue. There has also been a potential problem with detecting/scanning RFID chips through liquids due to shielding effects.

Track and Trace and RFID

Pharmaceutical product track and trace is becoming more and more important especially as radio frequency identification (RFID) technology matures and becomes less expensive (RFID chips can now be obtained as stickers or even printed directly on containers using special conductive inks). Track and Trace solutions incorporating RFID, 2D matrix barcodes and DNA codes are used to secure supply chain integrity and to enable suppliers to remotely monitor and protect the integrity of APIs and pharmaceutical products. The technology can provide continual real time visibility of the product's environment by using hidden tracking devices (these can be moulded into the structure of the container if required). The tracking devices are capable of gathering high accuracy product data including location, temperature, impact, humidity, vibration, pressure and then delivering it to a custom

web interface monitored by the manufacturer. Thresholds for each value can be set so that the exact conditions during transport are recorded. If a product encounters sudden drops in pressure or increased temperature then the tracking device will inform the interrogating computer, which can pass on warnings by e-mail or SMS. The system allows the provenance of high value and high risk pharmaceuticals and APIs to be recorded throughout transportation. The options for Track and Trace could include several technologies depending upon the level of security required or cost:

- A serial number in a bar code can provide simple and unique product identification
- For additional data transfer a data matrix or two-dimensional (2-D) bar code can encode lot and batch codes, product configuration information and even time and place of manufacture (there is much more potential for data storage in a small area)
- RFID based smart labels can hold more data and can even be re-encoded to update the chain of custody for the item
- Electronic Product Code (EPC) RFID technology is the highest level of security with the ability to combine several RFID encoding options with a standardised serial numbering system for unique identification of items. EPC is the leading option for track-and-trace systems in the pharmaceutical industry.



Seals are popular in tamper evidence as they immediately show tampering has occurred if they are torn or cut. One problem with the system is the 'peeling' of the label for later replacement but this has been combated with the introduction of special multi-layer low tack adhesive layers, which peel leaving an indicator behind. The complexity of the 'unique' company hologram design should also indicate whether the product is genuine or not.


In maintaining the security of high value pharmaceuticals, APIs and chemicals there are a number of systems that can be adopted. The integrity of the container needs to be secure with the appropriate tamper evident seals closures and lids. In addition, for the best security the transportation and provenance of the product needs to be monitored by the use of bar codes as well as track and trace.

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Dr. Huw Kidwell holds a PhD in organic chemistry and an MS in polymer chemistry. Following a spell working as a natural products chemist in Molecular Nature Ltd, he began to write full time, as a freelancer, for a number of business and technology journals (Packaging and Converting Intelligence, Packaging News, and Soft Drinks International) and websites (Pharmaceutical Technology, Packaging Technology, Chemicals Technology), on topics relating to packaging and design.

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