IMAGE: SHUTTERSTOCK

Additives take on fakers

*Counterfeit products present a risk to brand value and consumer safety. **Mark Holmes** finds out how taggant technologies are improving supply chain security and traceability*

The need for anti-counterfeiting features in plastic compounds continues to grow. Anti-counterfeiting additives have a clear benefit in providing protection and authentication for high value products and OEM brands across many market sectors. Beyond that, the technologies also provide the option to add traceability features to plastic materials to guarantee their provenance in terms of recycled content and broader circular economy compliance.

"The threats to consumers and international trade from counterfeiting and diversion of plastics are well documented," says Barry McDonogh, Senior Vice-President of Sales and Business Development at **TruTag Technologies**. "The illegitimate production and unauthorised distribution of products continues to threaten consumer safety and result in significant commercial losses. While efforts have been made to counter these threats through secure packaging, more can be done to reduce supply-chain risk and protect consumers by integrating authentication and traceability solutions directly into plastics," he says.

"In addition to counterfeiting, the requirement for traceability of plastics is increasingly being driven by the need to ensure the provenance of materials utilised in the economy," McDonogh adds.

"Taggants have long-provided plastic manufacturers and brands with a secure means of product authentication and traceability. These solutions work by emitting a distinct chemical or spectral signature. Taggants can be incorporated into a masterbatch and extruded into films or applied directly to plastics," he says.

However, McDonogh says traditional taggant solutions are limited by the need to use a proprietary imager for verification. This means only those with those imagers can detect the taggants, and this significantly reduces the potential for authenti-

Main image: The latest anti-counterfeit taggant technologies provide a means to protect brand value as well as enhancing material and product traceability

cation and engagement in the supply chain. "New digital taggants have been developed that address this limitation. These digital taggants can be detected by common cell phones. This means that anyone in the supply chain can interact with products through their smartphones," he says.

This digitisation offers not only a potential to secure the supply chain but for consumer engagement too, according to McDonogh. Consumers and brands can have immediate visibility of suspect events as they occur in the supply chain. This will enable customers to react in real-time to events that have the potential to impact consumer safety and have significant brand impacts. This can benefit all consumer products, specifically those impacting consumer safety. In addition to the security benefits, digitisation offers the potential for consumer engagement with end products – allowing brands to communicate and sell directly to consumers. This is particularly of importance for medium- to high-value products.

A further benefit is validating the circular economy. Many brands are investing heavily in the use of recycled materials for environmental reasons, says McDonogh. Digitisation provides a means by which the provenance of plastic material can be validated, particularly for high volume recycled plastics. The technology can also assist in warranty situations, for example, with products utilised in industrial applications such as gaskets, where failure can result in significant claims.

The latest developments by TruTag Technologies include a series of products for plastic films – such as PE, PVC, and PTFE, as well as shrink wraps for pharmaceutical and beverage packaging – which combine physical security with digital authentication. "For all technologies in this space, offerings are judged on the basis of a number of criteria," says McDonogh. "All solutions should have a base level of security that is sufficient to deter counterfeiters from targeting a specific product.

IMAGE: TRUUAG TECHNOLOGIES

Right: This TruTag taggant is extruded into a plastic film and can be identified by a cell phone torch light

Taggants can be incorporated into a masterbatch or applied directly to plastics

IMAGE: TRUUAG TECHNOLOGIES

Beyond that, customers are looking for low cost, ease of implementation and a something that can be authenticated on mass."

Global challenges

According to **Circularise**, as supply chains have become increasingly global and complex, the risk of counterfeit products and false claims of the characteristics of products grows. "This has resulted in a growing market for anti-counterfeiting technologies that can protect companies, who face legal liability that can cost millions as well as reputational damage, and consumers, who receive poor quality products," says Dr Shyaam Ramkumar, Lead in Business Development & Strategy at the company.

"An OECD study in 2019 identified that the value of counterfeit goods has reached US$509bn. And one of the companies developing solutions against counterfeiting, Kafrit Group, estimates that US$284bn will be spent by governments and companies to combat counterfeiting," he claims.

"One of the key roles for anti-counterfeiting focuses on traceability and marking technologies. The main aim is to authenticate and verify the properties of products through unique barcodes, QR codes, speciality inks, or chemical tracers as they move along the supply chain," Ramkumar says.

"While these technologies provide a way to identify counterfeit products, an underlying data infrastructure is required to track and trace these products in order to identify their sources and where in the supply chain problems occur. By combining these technologies with the hyperledg-

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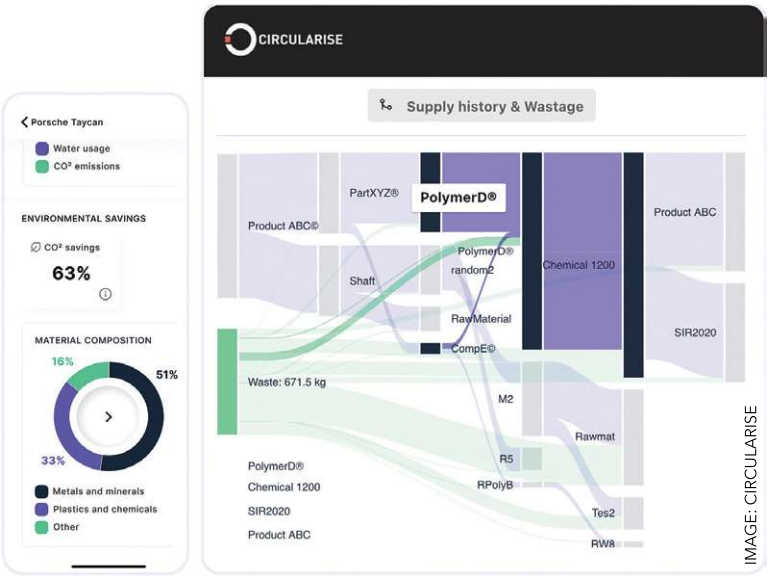

Circularise aims to combine anti-counterfeiting technologies such as labels, QR codes and chemical tracers with blockchain technology to provide a comprehensive anti-counterfeiting and traceability solution

er technology of blockchain, companies can track and trace all the transactions that take place across the supply chain," he says.

This hyperledger enables the creation of a complete ownership and authentication history, allowing companies to detect counterfeits at an early stage and identify their origin, according to Circularise. Moreover, the decentralised nature of the technology removes the need for trust among the parties involved (there are no intermediaries involved in managing and storing the data and all transactions are validated by all network participants).

Ramkumar adds that many industries can benefit from anti-counterfeiting and traceability measures for plastics compounds. For example, the automotive industry is recognised as a key market for counterfeit products. He says the US Federal Trade Commission has valued the counterfeit auto-part market at roughly US$12m per year. In 2020, he says Daimler identified nearly 1.7m counterfeit parts, three times the amount identified in 2019.

The most widely counterfeited products are clothing, and anti-counterfeiting and traceability solutions can have significant impact in this industry. In addition to the negative consequences of fake products that try to imitate brands, estimated to cost companies some US$30bn. There are also issues around greenwashing and verifying claims made by companies about the products, such as if they are made from sustainable or recycled synthetic fibres. Ramkumar cites a recent high profile case involving H&M that highlighted how a lack of transparency and traceability about the sustainability of products could see companies facing legal challenges.

Greater transparency of supply chains can be one of the most effective anti-counterfeiting measures. "Access to reliable data, such as material composition, product origin and environmental impacts, for example, can enable brands, OEMs and suppliers to improve reporting, reduce supply chain costs, strengthen their brands and avoid counterfeits," says Ramkumar. "However, many actors in the plastics value chain are hesitant to share information and data because of concerns around exposing sensitive and proprietary material composition information that could affect their competitive advantage."

Circularise argues that a distributed and decentralised public blockchain solution in combination with its Smart Questioning technology can provide an answer to this transparency challenge. "This technology allows safeguarding of the identity, business relations, production processes, and confidential information across all parties within the value chain. Through our Smart Questioning technology, only essential and useful insights will be shared between parties, and, if necessary, regulators. Since it utilises a public blockchain, the data cannot be tampered with and can be confidently trusted by all parties," Ramkumar says.

"We are continuing to explore how various anti-counterfeiting technologies like labels, QR codes and chemical tracers can be combined with our blockchain traceability technology to provide a comprehensive anti-counterfeiting and traceability solution for the plastics industry," he says. "With chemical tracers, we are identifying how spectroscopy data can be added as a data point on our system and how scanning hardware can directly interface with our solution to read plastic pellets and compounds in order to verify its authenticity."

Circularise says it is collaborating with companies that develop tracer technologies to test their application in the plastics industry. For example, it says it has worked with a sustainable textile entrepreneur and start-up based in Amsterdam, which applies tracer particles and blockchain to guarantee the recycled content of polyester and cotton fibres and fabrics.

"Since the chemical tracer technologies are still in their nascent stage, we are also exploring how we can collaborate with auditors and certification bodies within our platform," says Ramkumar. "We are developing solutions to enable these parties to conduct independent, third-party audits more easily and to reduce the administrative burden to gather all the relevant data and information. We have recently launched the MassBalancer tool to

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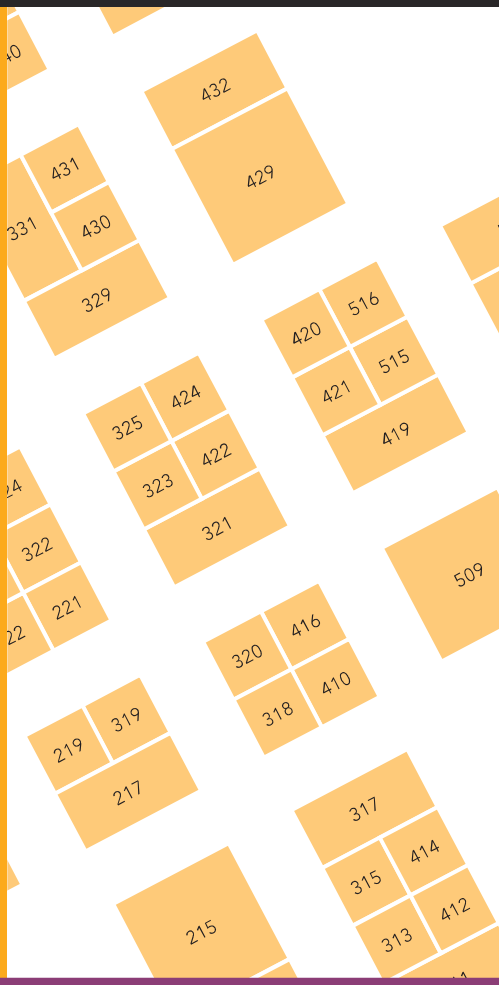

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IMAGE: DOTZ NANO

Above: Taggant technologies available from Dotz Nano include the ValiDotz range of liquid and solid markers

support the ISCC Plus certification scheme to manage credit balances for various production sites, automate reports on declarations, and gain in-depth insights, all from one place."

Track and trace

Over the past few years, **Dotz Nano** reports a significant increase in demand for plastics additives and marked masterbatches. "Track and trace for the circular economy and authentication for anti-counterfeiting are two main applications. Additional applications we have seen demand for are quality assurance, control of supply chain, and authentication of safety and biomedical products," says Shirley Shoshaney-Kleiner, the company's Marketing Director.

"As opposed to on-product techniques, such as RFID and NFC, in-product markers that can withstand often extreme production temperatures and pressures are the only means that allow for traceability and transparency of raw materials, rather than finished components or products, enabling full transparency of source materials across the supply chain. This also provides increased security because reverse engineering of these materials is extremely difficult," she says.

Shoshaney-Kleiner identifies three key application areas. Firstly, traditional anti-counterfeiting and authentication of polymer-based products or components that require higher security levels. These generally include high-value or sensitive products, such as biomedical and bioprocessing consumables and aviation and automotive plastic parts. A second area is supply chain control and transparency for ESG and related circular-economy initiatives, which are often driven by regulatory activities and consumers' growing awareness of sustainability issues. The third area of application is in-field quantification of materials for quality assurance and dosage management.

One of the most prominent trends driving technological advances in anti-counterfeiting and traceability of plastic compounds is the mandating of stricter circular economy-related programs, regulations and policies within the European Union and other regional jurisdictions. Full traceability of plastics compounds is a prerequisite of plastic recycling as there is a need to understand the composition and the quality of the plastic product prior to the recycling processes. The latest advances in in-product marking technologies allow for real-time quantification of plastic compounds to enable a much higher level of supply chain and product management than was previously possible.

Dotz Nano has identified a number of current technical areas of interest. "These include the development of markers and masterbatches that can withstand extreme conditions, such as high temperatures exceeding 300°C and prolonged exposure to direct UV sunlight," says Dr Michael Shtein, Chief Technical Officer and Co-founder. "These are needed for a range of applications including an area where we see high demand, such as agricultural greenhouses. Dotz Nano has developed a series of markers that can withstand temperatures of up to 500°C and have photostability of years and we see our next challenge in developing food-grade markers that may have direct contact with food ingredients. We have already started work on that both in terms of R&D and regulation."

The company has developed a family of ValiDotz markers that can be added in small quantities to any kind of plastics, from simple polymers to high-performance plastics, during processing. "These markers do not change the plastic properties or appearance, and are able to withstand extreme conditions such as high temperatures and pressures during production, or conditions of use such as high photostability that allows integration of those markers into products exposed to direct sunlight," says Shoshaney-Kleiner.

"Detection takes place using our miniature hand-held InSpec detectors that are pre-programmed to detect the specific marker, giving real-time indications of whether the product is authentic. This is a huge advantage to previously needing to take samples off-site to have them externally tested for authenticity," she says.

Dotz Nano has recently been involved in a project with a customer from the healthcare industry looking for a solution to mark its plastic-made testing consumables to prevent fraud. In order to meet the customers' requirements, a unique ValiDotz marker was inserted to the thermoplastic material as a masterbatch, prior to

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Right: The InSpec-S miniature handheld surface optical detector from Dotz Nano can be pre-programmed to a specific marker

injection moulding. Detection took place using the InSpec miniature handheld detector to offer real-time authentication and prevent fraud.

Product passports

German company **Polysecure** reports that while signs of interest are visible, anti-counterfeiting additives for plastic compounds remains a niche market. "Traceability for individual products appears to have some momentum, especially in the context of product passports and Industry 4.0 applications. In addition, supply chain monitoring for the circular economy is also drawing increasing interest. The EU commission is also putting forward legislation pertaining to Digital Product Passports (DPP) and Digital Material Passports (DMP)," says Jochen Moesslein, Managing Director.

"Original product manufacturers (OEMs) are also looking to anti-counterfeiting measures to protect themselves from unjustified liability and warranty claims. With our Particle-Fingerprint (PFP) technology, OEMs can combine anti-counterfeiting with individual traceability because the PFP pattern are both individual and forgery-proof. They are created by random processes in the material and therefore cannot be copied," he says.

Moesslein adds that the main technical area of development is the need for robust and forgery-proof unique identifier technology and detection. While there are many companies and people involved in the creation of product pass databases, for example, he says few resources are available and focused on the physical unique identifier technology. To meet this need, the company has developed its PFP technology for DPP and Poltag technology for DMP applications.

The company says the uniqueness and counterfeit protection of individual product identification is of central importance when mapping DPPs. With its PFP technology, upconversion fluorescence particles are added to the plastic compounds. These arrange themselves randomly during the solidification process and their position is measured.

Due to the upconversion effect, only the fluorescent particles emit visible light when excited with suitable radiation. All other material components remain dark. This results in a comparatively high contrast, which in turn enables reliable, fast measurement at very low particle concentrations. Due to the randomness, the resulting 'fingerprint' is unique and cannot be copied and reproduced. In contrast to barcodes, RFID tags or digital watermarks, PFPs are forgery-proof, according to Polysecure.

The fluorescent particles are crystalline particles (greater than 1 micron) that are thermally and

IMAGE: DOTZ NANO

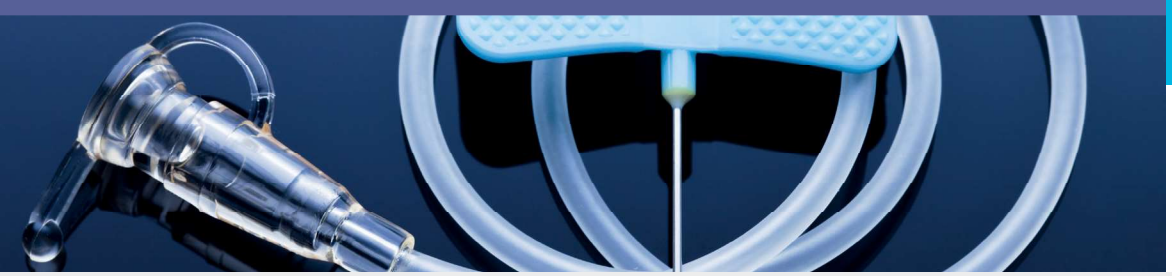
chemically stable. They have good biocompatibility and are compliant with EU substance law requirements. The company says EU approval for contact with drinking water has already been granted and approval for food contact is expected soon (it says toxicological tests have been completed with good results).

Polysecure says PFP applications include electronic goods, medical products and general products that are at risk of counterfeiting, requiring a secure return system or that need a product passport for regulatory reasons.

Secure authentication

In collaboration with the Charles Sadron Institute (ICS), the company has developed its Poltag technology to allow DMPs to be anchored in the material. Poltag provides a secure and accurate identification technology for materials that can solve challenges such as authentication of materials or material components to ward off unjustified warranty claims triggered by other materials or counterfeits. It can also be used to trace materials or material components for origin, certification, composition, manufacturing and batch data to meet regulatory or organisational requirements. Monitoring of recyclates and materials in the circular economy can also be undertaken.

Poltags are organic macromolecules with a monomer arrangement that can be specifically synthesised. Due to the practically unlimited combinational possibilities, the company says millions of individual molecules, and therefore distinguishable codes, can be generated. This allows the identification of a correspondingly large number of materials in a 'material DNA'. Data in the



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identification codes can include any information, such as manufacturer, batch number or production date, so that materials can be traced back to their origin.

Technical properties of the Poltag molecules can be adjusted and adapted to ensure maximum stability and compatibility with the target product and its specific application. They are designed and synthesised individually for each customer by Polysecure, which ensures a particularly high level of protection against counterfeiting and manipulation.

Poltags are thermally stable up to 380°C, chemically stable through resistance, for example, to UV radiation, acidic and basic solutions and organic solvents, as well as being mechanically stable. These robust properties, together with the anchoring of the Poltags directly in the material, means they can be preserved and detected for many years.

Poltags can be homogeneously processed in solids (for example, thermoplastics and duroplastics) and liquids, such as organic solutions, fuels and water-based liquids.

Poltag macromolecules are identified by tandem mass spectroscopy (MS/MS). Only a few 100mg of labelled material is required for precise detection, which in polymers is around 1ppm. The quantitative nature of mass spectroscopy means detection of Poltags can also be used to monitor and measure the concentration of marked materials in an end product, such as recyclate content.

Moesslein says that Polysecure has received legal confirmation that its Brandproof mobile pocket detector technology is now accepted in German courts for authentication of products. In future, the company says that it will also provide its PFP identification software via a secure internet database so that customers can link the individual hash codes with their DPP databases.

Right: Particle-Fingerprint technology from Polysecure allows OEMs to combine anti-counter-feiting features with individual traceability

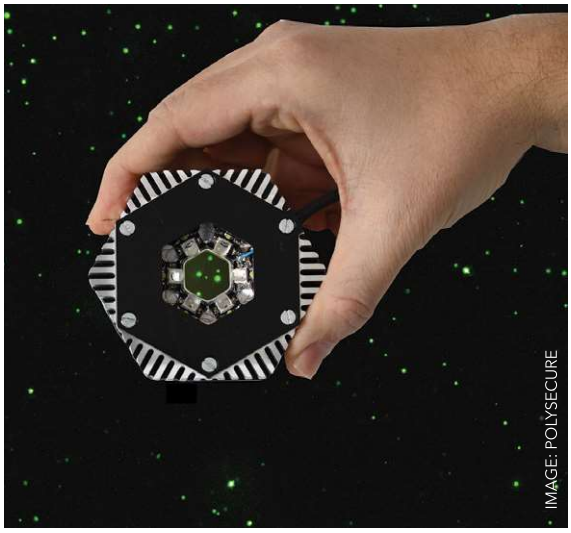

IMAGE: POLYSECURE

Taggant integration

Avient has developed its Plastiward counterfeiting technology to provide protection for plastic articles in multiple applications. Offering fake checking in real-time, the company says Plastiward brings counterfeiting protection of plastic articles close to the end consumer by integrating taggants into a product using a polymer masterbatch. It describes it as a fully integrated turnkey solution that allows an enforcement team to take swift action against fraud.

Plastiward combines Avient's polymer modification expertise with the in brand protection technologies developed by banknote security ink specialist Sicpa. It uses proprietary taggants integrated directly within the polymer together with a handheld detector to offer instant fake checking in the field. A secure monitoring platform running on a smartphone or tablet captures field inspection data, which is transmitted in real-time.

BASF Venture Capital (BVC) recently made a strategic investment in Oceanworks, a sustainable plastic solutions provider that aims to deliver traceability and transparency to recycled plastics through digitalisation. Based in the US, Oceanworks offers a platform for brands looking to reliably secure high-quality sources of ocean, ocean-bound, and averted post-consumer recycled (PCR) plastics. Its offering to clients includes digitised blockchain-based traceability, material quality assurance, global logistics and marketing support.

Below: Avient says its Plastiward technology has already been applied in the E&E sector

IMAGE: AVIENT

CLICK ON THE LINKS FOR MORE INFORMATION:

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