



SMART INKS FOR MARKING AND CODING FOOD PACKAGING

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Coping with manufacturing conditions

Food and drink manufacturers prepare and pack their products in challenging environments. Amid the steam, grease, and scalding heat, they have to apply their batch codes, best-before dates, and other useful data. That's when manufacturers need the right ink for the right application – where it has the ability to cut through the obstructions and stay put on a wide range of packaging materials.

This white paper explains how manufacturers of inks for Continuous Ink Jet (CIJ) coding are developing smarter inks to overcome the challenges of printing on tricky substrates and in demanding manufacturing conditions. Their approach is not to create an ink for every application, but to develop a range of inks that are versatile enough to cope with the latest consumer-driven marking challenges.

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1 Product safety and efficient manufacturing depend on reliable marking and coding

Reliable batch codes, best-before dates, and use-by dates are the backbone of a sound manufacturing process. If production managers can't trace a product and its ingredients all the way through the supply chain, they can't identify problems or gather the data they need to improve their manufacturing processes. Besides, coding and traceability are a legal requirement.

As consumer tastes and environmental challenges evolve, the industry becomes ever more diverse and resourceful. Every packaging innovation creates a new challenge for CIJ ink manufacturers. To provide batch codes that stay legible, they develop inks that are versatile enough to cope with whatever the market and their customers' production, storage, and distribution processes throw at them.

In modern production processes this is easier said than done. Food manufacturers use a variety of packaging materials, and they prepare, sterilise, and seal in a wide range of conditions. The process can be hot, damp, and greasy, or even cold. Their production lines can run at thousands of items an hour, and the finished product may be frozen, reheated, flexed, shrunk, scuffed, and washed during the journey from factory to dining table.



Flexible plastic packaging

2 Marking inks for substrates that flex or change shape

Flexible materials can help manufacturers cut packaging costs. Flexible packaging consumes less energy and fewer resources, and takes up less space than rigid packaging. Flexible plastic packaging is also highly versatile: manufacturers can cook or sterilise their products inside the sealed pack, the plastics are non-permeable, and consumers can see the contents.

Adhering to flexible substrates is a challenge for a marking ink. At various stages in the journey from production line to consumer, the substrate will expand, contract, or change shape. Some plastics even undergo a change in chemical structure when heated. To accommodate these changes, the CIJ marking ink has to stay flexible. If the ink becomes brittle, it cracks and flakes away when the substrate bends.

There are various ways of overcoming this problem. Some marking inks contain solvents that attack the outermost surface layer of the substrate. This allows the colourant and other components of the ink to intimately mix with the substrate, promoting the formation of chemical bonds.

In other cases, the nature of the binder is considered. The binder is a resin or polymer that holds the colourant to the substrate. If the substrate is viewed at the molecular level, charge separation can often occur between the bonded atoms, resulting in permanent areas of slightly positive and slightly negative charge, known as 'polarity'. By choosing a binder which also has polarity, the binder and substrate molecules can align to form strong van der Waals bonds – a bond based on the attraction of opposite charges.

Binders are screened for their effectiveness on a range of substrates typically found in the food industry. They are subjected to rigorous removal tests that mimic what happens during the lifespan of the product. These tests ensure that the ink will stick – and remain stuck – to the product.



Vacuum packaging produces an irregular surface for printing

3 Marking inks that survive cooking or sterilisation

People have been preserving food using packaging since Napoleonic times; it's a great way to lock in the nutrients when food is at its best. The packaging provides an airtight environment, the contents need no preservatives, and the packaging enjoys a long shelf-life.

For batch codes that survive the high temperatures of retort or sterilisation processes, manufacturers need a heat-resistant ink with a stable binder system. They need a binder that won't melt, run, degrade, or dry out at sterilisation temperatures.

In this case a polymer-based binder with an appropriate glass-transition temperature is used. The glass-transition temperature (symbol T_g) marks the point at which the polymer changes from being hard and relatively brittle into a more viscous or rubbery state. The polymer becomes more flexible, but it doesn't run.

Since molecules have a tendency to break down when subject to heat, it is also important to ensure that none of the ink's other components undergo undesirable chemical changes at higher temperatures.



Food cans undergo a retort process

4 Marking inks that survive blast freezing

The quickest way to freeze a product is to blast-freeze it in a fast-moving current of cold air. Speed is essential because naturally occurring bacteria multiply rapidly on foods at ordinary temperatures. Blast-freezing halts the process.

Blast-freezing also locks in nutrients and maintains food colours and textures. Cell damage is limited because the ice crystals that form during blast-freezing are much smaller than those that develop during normal freezing. The process captures and retains product quality as it stands at the point of freezing.



Frozen flexible plastic packaging

Like the heat challenge in section 3 above, the glass-transition temperature also plays a part. To help with low-temperature flexibility, phthalate-free plasticisers are added. Plasticisers maintain flexibility by lubricating at the molecular level. They enable complex molecules to continue to slide past each other even when they're frozen. They create an ink that doesn't go brittle at blast-freezer temperatures.

5 Marking inks that cut through grease and releasing agents

If a marking ink doesn't get a good hold on a packaging material, it can rub off in use. Once it's gone, the batch code and best-before date are lost and the packaging no longer meets food standards.

This is a particular problem in food production where thin layers of grease or oil often adhere to the surface of the packaging. The oily layer, which can come from airborne oils emanating from the foods or from releasing agents applied to help packaging fall from moulds, forms a barrier that stops the ink reaching the substrate. In the past, the grease would have to be removed before a marking ink could be applied. Nowadays technology is available to cut through the grease.

To stick to a greasy substrate, a marking ink has to find its way through tiny gaps in the grease molecules to reach and adhere to the surface below. To achieve a good bond, the marking ink doesn't have to cover the entire area. As long as there are enough suitable anchors in the substrate, it will stay put.

The key is to work with the varying surface tensions of the substrate, the ink, and the grease. With the right additives, the ink will avoid the grease, wet the surface of the substrate, and cling tight to the packaging.

Packaging may have a surface layer of oil



6 Marking inks for oxygen-scavenging plastics

Oxygen degrades food, so the packaging industry is always looking for ways to remove or eliminate it. In the past, manufacturers have added a sachet of oxygen-scavenging chemicals to the pack, which adds costs and additional processes. A more efficient method is to pack the food product in an oxygen-scavenging plastic – a plastic that absorbs and neutralises oxygen.

Since oxygen-scavenging additives can alter the surface properties of the plastic, marking inks for ordinary plastics may be unsuitable for this market. Using their knowledge and experience of adhesion onto plastic substrates, and choosing an appropriate combination of binder and additive technology, CIJ ink manufacturers are able to offer inks that will stick to oxygen-scavenging plastics.

7 Marking inks that change colour when heated

Some marking inks are not just static recorders of historic data. They tell manufacturers that the product has been subjected to a certain level of heat for a certain period of time. These thermochromic inks change colour when subjected to a retort or wet heat process. They are a visual indicator that the product has been through the process, but they're not a guarantee that the process was properly conducted. The production team still have to manage and monitor the temperature and duration of the process.

When subjected to heat and moisture, the components of a thermochromic ink undergo an irreversible structural change. Because the post-heat structure reflects light differently to the pre-heat structure, it shows itself as a different colour. Typical heat-driven colour changes are purple to pink and black to blue.



Thermochromic inks undergo a colour change during a retort process

8 Talk to an expert to get the ink that's right for your product, your manufacturing process, and your end user

As this paper shows, there is a marking ink for just about every application. That's why, when food businesses develop their products and processes, they can rely on Linx to find the best solution to cope with their new manufacturing conditions or to improve existing processes. They can rely on us to help them meet their legal obligations.

As new packaging materials and formats come into play, manufacturers will face new marking challenges. We, too, are working to improve our inks, and believe that we can keep our range versatile enough to cope with those challenges. As packaging technology and customer expectations evolve, we have the skills and experience in-house to formulate inks that will meet the future needs of manufacturers.

For consumers and food manufacturers, the future looks bright. Innovations in both products and packaging will continue to drive sales up and costs down. At the same time, the parallel development of CIJ ink technology ensures long-term compliance and product safety. These are exciting times to be packaging food and drinks.

About the author, Dr. Richard Marsden

Dr. Richard Marsden has a degree and Ph.D. in Colour Chemistry from the University of Leeds, followed by postdoctoral fellowships in Synthetic Organic Chemistry at McMaster University in Canada and Hull University, UK. He first worked on CIJ inks for binary systems with Elmjet, before joining Linx Printing Technologies in 1990. He is a chartered chemist and member of the Royal Society of Chemistry.

About Linx Printing Technologies

Linx Printing Technologies is one of the few global CIJ companies in the market. In 1992 we began to develop our own inks. Within a year we'd become one of the first companies to produce a mixed-base, low-odour ink which would adhere to most materials, making it ideal for food packaging. We continue to research and develop our own inks to this day.



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