Ultrasonic boom

It is not for every industry, but for the right application, the benefits of ultrasonic sealing could be game-changing. Steven Pacitti reports

Various methods are used to join thermoplastic packaging materials or composites with a thermoplastic sealing layer, and most methods in the past involved heat contact.

But although heat-seal systems remain the most common bonding solution, many technology leaders believe that the process could be bettered by ultrasonic sealing. This is particularly true of the food packaging sector, they claim, due to ultrasonic's potential to deliver fully repeatable, 100 per cent reject-free products despite seal contamination, while streamlining production.

Ultrasonic joining technology was developed in the 1960s and was used mainly in the automotive industry. However, its success in this sector led to its application in the sealing of blister packages, where it continues to be a preferred manufacturing method.

Since then, ultrasonics has made substantial inroads into several industries, including filtration, non-wovens, medical and, of course, packaging where its ability to deliver hermetic seals even though contaminated by the product has been seen as a great advantage. The high vibration frequencies used in the ultrasonic process shakes away any food product from the seal area that could compromise a hermetic seal.

As the technology evolved into the packaging market, applications have included beverage carton sealing, tube sealing, stand-up pouch sealing, and vertical (VFFS) and horizontal (HFFS) pouch sealing.

Above: An ultrasonic module incorporated into a horizontal form-fill-seal pouch line

Left: Fresh produce benefits from a superior seal

"Industries where customers have leaker problems or where there is a need to reduce material (head space) are suitable application areas for ultrasonic sealing," explains Uwe Peregi, executive vice president and general manager of Herrmann Ultrasonics in the US, a supplier of ultrasonic-sealing technology.

One of Herrmann Ultrasonics' major customers is a high-volume manufacturer of stand-up drinks pouches and, according to Peregi, the use of ultrasonics has resulted in that manufacturer achieving higher throughput with no leakers for a properly presented pouch, even when product splash from the filling process was present in the seal area.

A major opportunity for ultrasonic sealing could be cheese packaging, which has always relied on heat-sealing technology. According to flexible packaging manufacturer Curwood, which is part of US-based Bemis Corporation and is a major supplier to the cheese market, leakers caused by defective seals, and related issues of mould or moisture loss that can occur in grated cheese packaging, is a problem connected with VFFS pouch heat-sealing.

In retort applications, the reject rate of ultrasonics is significantly less than one per 10,000 seals. With its high-speed production, ultrasonics lends itself well to the high-volume cheese packaging sector. However, more work needs to be done in the development of thinner, faster and stronger flexible materials that meet barrier and aesthetic needs, in order for ultrasonics to become truly optimised for cheese and pouch applications and to challenge heat-sealing.

Robert Hueber, sales manager packaging at Germany-based Herrmann Ultraschall, goes further: "Our customers use laminates containing an inside thermoplastic sealing layer, in most cases PE or PP. The laminate structure required for ultrasonic sealing is similar compared to laminates for heat sealing. The sealing layer needs to be optimised for ultrasonic sealing as not all thermoplastics respond to ultrasonics in the same way. Special film characteristics like a good 'hot tack' are not required for ultrasonic sealing and therefore less-costly PE or PP types can be used.

"As ultrasonic tools usually stay cold during production and the friction heat originates from within the sealing layer, even monopolymers or mono-coex-polymers can be used up to a total thickness of 100 microns."

Aside from cheese, ultrasonics have already been commercialised in hot-filled and retort liquid applications including sauces, chocolate and meat, beverage pouches, and recloseable zipper welding onto film.

Ultrasonic sealing has so far been more prevalent in Europe and although there are industries in the US familiar with ultrasonic sealing, others, including the cheese industry, have not yet had widespread acceptance.

US-based Triangle Package Machinery Company has worked with Herrmann Ultrasonics since 2008 and Bob Williams, the company's vice president of sales and marketing, believes that high-end products that rely on a superior-looking bag will see benefits from ultrasonic sealing.

"Fresh produce, lettuce, liquids, and cereals are all products that rely on superior seals. Many companies with bag-in-box products may also be able to eliminate the traditional carton, further reducing the amount of packaging materials needed to get their products to market," he says. "Finally, the fact that ultrasonic sealing is 'cool' will be beneficial to industries where products are adversely affected by heat, such as chocolate products."

Williams believes that a major contributing factor to the slower uptake of the technology in the US has been the cost of it, particularly in the VFFS industry.

"For the most part, in recent years US VFFS original-equipment manufacturers have been chasing customers who continue to look for cheaper, less-expensive machinery.

"The biggest challenge in VFFS is the integrity of the end-seals and back-seal. We are literally forming the bag around the product as it is falling down a tube, so these seals must be completed and set before the product comes in contact with them, so the bag can be properly formed. Our early tests have confirmed that package seals made ultrasonically are far superior to seals made with traditional heat-sealing technology."

Ultrasonic seals use less film for the actual seal area and also clear certain products out

of the seal area (thereby avoiding leakers that can lead to seal failure and product degradation/contamination within the bag).

"We've actually sealed empty bags with ultrasonic end- and back-seals, and had people stand on the bags without breaking any of the seals. This means the consumer can be assured of a product that arrives in the home as fresh as it was when it was first packaged."

Pros and cons

In heat sealing, composite materials with an outer thermoplastic layer are joined by applying heat and pressure from the outside, and the thermoplastic sealing layers are bonded together. Material type therefore affects sealing time, cooling time, sealing temperature and sealing pressure.

Ultrasonic sealing differs by only heating the joining zone from the inside, regardless of whether mono or composite materials are being joined.

According to Herrmann Ultrasonics, recent developments in the technology have enabled both continuous longitudinal seals and intermittent cross seals to be integrated into one packaging system, while it is also possible to use thinner laminate structures and lower-cost based polymer sealant films. This, claims the company, saves up to 30 per cent in material and energy costs.

To explain the process, ultrasonic welding is based on the conversion of mechanical sound waves in a thermoplastic into frictional heat, resulting in material bonding at the molecular level. Ultrasonic vibrations are introduced into materials via a generator in the form of longitudinal waves, and mechanical energy is then focused on the desired area of the sealing zone to melt the materials. When the ultrasonic energy is removed, the material in the sealing layer solidifies.

As the contact area is small, ultrasonic created seams are narrower than heat seams. However, the major difference between ultrasonic and heat contact sealing methods can be seen in the temperature distribution.

The temperature at the surface of the packaging material is higher than in the sealing zone during heat sealing, so heat continues to flow into the interior of the seam after the sealing tool is removed. Therefore, a cooling period is required to achieve a strong seam. High sealing tool temperatures can cause thermal degradation of the packaging material (shrinking or burns), or damage to contents.

In the ultrasonic sealing process, heat needed for melting is generated in the sealing zone only inside the seam (sealing layer), while the substrate layer remains practically cold and when energy is no longer introduced, the heat dissipates to the outside more quickly because of the temperature difference between the substrate and the sealing layer.

According to Bosch Packaging Technology, which manufactures ultrasonic sealing systems, ultrasonic sealing offers a number of advantages over heat sealing, including reduced welding and holding times, less thermal load on the product, leak-proof sealing of contaminated surfaces, potential savings of packaging material, a greater range of packaging materials that can be used, and the system is ready as soon as the machine starts.

Heat sealing is preferable for those seeking lower investment costs, less noise, and less restriction when it comes to sealing tool size.

Yet the payback time for ultrasonic systems is in a range of 6-20 months, due to savings generated by energy reductions, productivity gains, waste reduction and reduced packaging material. In fact, it uses 20-25 per cent less energy than heat sealing.

The sealing time of ultrasonic is just 80-200 milliseconds, which is useful for thick packaging materials or when combinations of injection moulded packaging materials and film are being sealed.

Using ultrasonic sealing

A typical ultrasonic solution is integrated into an existing automated heat sealing system. Where appropriate, a heat sealing system is removed and replaced with ultrasonics in the same station.

While ultrasonics is applicable to most of the substrates and film structures that are currently available in the packaging industry, it is important for companies like Herrmann Ultraschall to develop close relationships with various film suppliers and develop simplified, low-cost structures.

"In the past, standard ultrasonic components and technologies from the plastics industry were used and implemented. Without understanding and addressing the challenges in the packaging industry, success was limited," explains Peregi.

To succeed in areas such as cheese packaging, cheese processors, film, sealing companies and machinery companies will need to work closer together than ever before. The cheese industry may even need to rethink its current supply model in order to successfully incorporate ultrasonics.

Ultrasonic sealing systems are much more expensive (4-8 times) than heat-sealing, so it probably will not be beneficial for low-cost products that can be packaged on low-end/low-cost baggers, or where the integrity of the package seals is not of value to the end-user.

And it remains to be seen how robust the ultrasonic components used to produce the seals are in a harsh production environment. There are times in VFFS packaging when products fall inadvertently into the sealing jaw area as the jaws are closing. It will have to be determined how the components respond following a product jam condition. However, current experience suggests that industries that package dense or bone-in products might be good candidates for ultrasonic sealing. P

More information from Herrmann Ultraschall. www.herrmannultraschall.com. Triangle Package Machinery. www.trianglepackage.com