



WHITEPAPER „A GUIDE TO A MORE SUSTAINABLE PACKAGING PROCESS“

Reduce rejects and energy consumption
with ultrasonics

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1. SUSTAINABLE PACKAGING: A MUST HAVE

Studies show: three out of four consumers already value sustainable packaging¹. In addition to these consumer demands, even stricter packaging laws are putting increasing pressure on the industry and demand that sustainability targets be met quickly.

To achieve these goals, packaging companies not only need environmentally friendly materials, but also new sealing processes that guarantee sustainable, safe and economical packaging. They can support companies in several ways at once, by:

- Enabling the processing of mono-materials
- Reducing reject rates
- Saving packaging material
- Reducing energy consumption
- Increasing the shelf life of food

On the way to an environmentally friendly packaging process, the use of ultrasonics has proven its worth for years. In this process, the packaging materials are joined together gently, quickly and reproducibly. The required heat is generated by friction and is not applied externally, compared to conventional processes.

In this white paper, you will learn how ultrasonic technology can help your company make your packaging process more sustainable while simultaneously more economical.

2. THE USE OF SUSTAINABLE PACKAGING MATERIALS

To make the packaging process more sustainable and reduce the use of plastic packaging, new packaging materials are constantly entering the market. In recent years, the use of mono-materials has increased due to the ability of being recycled and returned to the circular economy. Paper-based packaging materials are also being used more and more frequently in sectors such as cosmetics and significantly reduce the proportion of plastic.

However, even though the new materials promise more sustainability, their acceptance is hindered by the complex requirements of further processing. Environmentally friendly packaging materials are significantly more sensitive to external heat input. Conventional processes, such as heat sealing or heat



Sustainable packaging is playing an increasingly important role for consumers.



¹ <https://www.neue-verpackung.de/nachhaltige-verpackungen/wie-verbraucher-ueber-nachhaltigkeit-informiert-werden-wollen-54-399.html> (German language)

contact welding, reach their limits when sealing these materials and endanger not only the appearance but also the tightness of the packaging. Ultrasonic sealing, on the other hand, has proven to be a future-proof technology. Since heat is generated inside the materials for only an extremely short time, neither optics nor tightness are compromised.

Tests in the ultrasonic laboratory as well as applications in continuous operation show that ultrasonics are well suited for a wide range of sustainable packaging materials.

2.1. MONO-MATERIALS

On the way to a sustainable packaging industry, the use of mono-materials is an important tool. Primarily they are used in applications for packaging wet pet food, but also for film packaging for freshly cut lettuce. Since the mono-materials can be recycled, they make a decisive contribution to reducing plastic waste. The rule is: the purer the packaging material, the better it can be reused.

Single-layer films or recyclable composites such as PP or PE are extremely vulnerable to thermal damage due to their sensitive material properties. The energy input in the sealing process must be precisely determined and controlled in order not to risk damaging the material. The appropriate parameters are defined in advance by numerous welding tests and reliably reproduced in everyday production. In this way, it is possible to heat only the interior of the material. The base layer, although made of the same material, is not melted and remains completely intact.

2.2. PAPER-BASED PACKAGING MATERIALS

In addition to mono-materials, the use of paper-based packaging is also increasing in the industry. They are usually not made of pure paper, but contain a certain amount of plastic, which serves as a barrier to protect the food.

The percentage of plastic used within paper-based packaging may vary from country to country. While in Germany only five percent plastic may be present, in other countries this value can be over 20 percent. Although a high plastic content makes it easier to process the material, it can no longer be recycled. Only paper packaging that contains a small amount of plastic and can be returned to the cycle is considered truly sustainable.

The use of ultrasonics serves as a safe joining technology that can bond packaging with a low plastic content. Burns on the paper as well as other optical impairments are avoided thanks to cold welding tools. This applies both to



Mono-materials can significantly reduce plastic consumption.



Paper-based packaging is often used for cosmetics.

thinner paper layers and thicker carton packaging materials, similar to those used for beverage cartons.

Noticeably in beverage cartons, thin aluminum was often used as a layer inside, which made it possible to seal the packaging by induction welding. This aluminum layer is being phased out from packaging for sustainable reasons, which means that alternative joining processes such as ultrasonic sealing are needed.

Customer Story: Verdesoft

Together with packaging service provider Verdesoft, Herrmann Ultraschall has developed a cup and a tube made of paper-based packaging materials that can be sealed using ultrasonics. The packaging concepts have comparable product protection to conventional plastic packaging while saving up to 75 percent plastic.



2.3. BIO-PLASTICS

Compared to conventional plastics, known bioplastics also show good sealing behavior with ultrasonics. PLA in particular is already being used in a variety of ways, for example more sustainable coffee capsules that are sealed with ultrasonics. Starch- and sugar-based bioplastics are increasingly used in the packaging industry as well and can be reliably sealed with ultrasonics.

The main precondition for processing bioplastics with ultrasonics is a thermoplastic content in the packaging material. As with any new application, it depends primarily on the design of the packaging and the quality of the material. The weldability of a new bioplastic can be determined in feasibility tests in ultrasonic laboratories.

Gentle on climate & food

By generating heat only inside the films and not adding it from the outside, the food inside the package is also protected from external heat during ultrasonic sealing. This helps reduce waste and ensure shelf life while reducing energy consumption.



3. LONG-TERM REDUCTION OF REJECTS

The generation of rejects is not only an unpleasant cost factor because it can be avoided, but it also has a negative impact on the sustainability balance sheet of packaging companies. Just a few faulty packages can lead to the disposal of entire production batches, wasting a considerable amount of perfectly packaged food. In addition to this food waste, packaging waste is also generated for the company, which is reflected in the environmental footprint. Reducing waste as much as possible has to be one of the most important goals for packaging companies.



3.1. AVOIDING LEAKY PACKAGING THROUGH ULTRASONICS

One of the most common causes of rejects is leaking packaging. Research by the Industrial Association of Food Packaging in Germany (IVLV) has shown that contaminated sealing surfaces due to food residues reduce seal strength by 88 percent.² The most common contaminants include particles, product spills and condensation.



Contamination during thermal sealing processes affects the tightness of the packaging.

Overall, studies have found quality defects in more than one-third of all final packages. In 58 percent of these defects, contamination in the sealing area is the main cause of the damaged packaging³. The shelf life of the food and the satisfaction of the end consumer are then directly impacted.

Sealing with ultrasonics offers more security. Ultrasonic sealing causes the materials to vibrate between 20,000 and 35,000 times per second, depending on the application. These vibrations ensure that not only particles or liquids, but larger contaminants such as lettuce leaves, are displaced from the area of the hermetic seal. As a result, the area remains free of contamination and an absolutely tight seal is produced which ensures that the shelf life of food is extended.



Ultrasonics displace product residues from the sealing area.

² Evaluation and optimization of sealing behavior in the event of seam contamination of food packaging (German language): <https://www.ivlv.org/media/Zusammenfassung-Schlussbericht-2.pdf?c=1d341876fd89bfc9fc32b99cb97405c93c22baa875ad29dbdee4a219d7b56d6b>

³ See above.

Material savings through narrower seals

The risk of contamination from heat sealing usually leads to packaging being sealed with wide seals. This takes up a significant amount of packaging material. Since ultrasonic sealing works safely and reliably even with contamination in the sealing area, the packaging for this process can be designed smaller or filled with more contents. This saves a substantial amount of material, which then reduces costs and the environmental impact.



Thermally welded seals (left) are wider than ultrasonics seals (right) due to the risk of contamination in the sealing area.

3.2. PROCESS MONITORING ENSURES QUALITY

Before ultrasonic sealing is used, the ideal welding parameters are determined for each material or for each customer application. These include, for example, the welding time, amplitude or welding force. By determining an optimum process window in this way, a reproducible sealing result can be guaranteed, in which even fluctuations in the composition of the packaging material are compensated for.

The sealing parameters are saved in the control system of the generator. This control system monitors and evaluates each individual sealing process. If a faulty sealing process occurs, for instance due to incorrect bag positions, this is immediately detected and the generator initiates the rejection of the faulty packaging.

Until now, such damaged packaging was usually only detected when it was already in transit. This resulted in the disposal of entire pallets, as it was difficult to identify individual, leaking packages. With continuous process monitoring by the generator's control system, this identification takes place immediately after the sealing process, which saves several tons of scrap in daily production.



Customer Story: Pet food

A customer that packs moist, chunky cat food in pouches was able to reduce the number of leaking packages from 0.05% to 0.001% by switching from heat contact welding to ultrasonic sealing systems from Herrmann.

It doesn't sound like much, but it's enormous: this saves over 4.4 tons of cat food per day – equivalent to the weight of a fully-grown elephant.



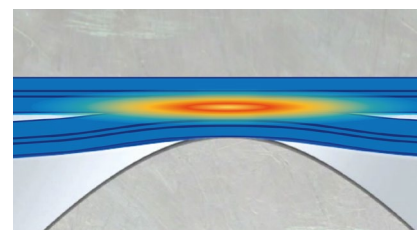
4. EFFICIENT USE OF ENERGY

One of the environmental factors in the packaging process with the highest savings potential is energy consumption. Due to rising electricity prices, this is becoming an increasingly serious cost factor, which is why this is not only an opportunity for companies to package more sustainably, but also more cost-efficiently.

Especially compared to processes such as heat sealing, the use of ultrasonics offers a significantly more efficient alternative. This is primarily due to the precise use of energy. The ultrasonic generator produces high voltage, which is converted into mechanical vibration by a converter. The welding tool – the sonotrode – transmits this vibration to the packaging materials, such as films or laminates. The pressure and ultrasonic vibration of the components generate heat into the materials to allow the individual layers to flow and bond together on a molecular level. The bonded materials create a 100 percent leak proof seal.

The great advantage: energy is only required within the short sealing time of usually 100 to 200 milliseconds. The welding tools remain cold and are thus immediately ready for use – there is no need for heating up. In addition, the amount of energy input can be controlled very precisely via the generator – this not only ensures a more efficient process, but also enables greater control and quality assurance.

The potential for energy savings becomes particularly clear in a direct comparison of the sealing processes:



Heat is only generated within the films during ultrasonic sealing.

Example: stand up pouch with 93 mm top seal	Heat sealing	Ultrasonic sealing
Production speed	60 pouches/minute	60 pouches/minute
Average energy consumption per hour	0.5 kWh	0.1 kWh ⁴
Average energy consumption per day ⁵	12 kWh	2,4 kWh
Average energy consumption per year ⁶	3,600 kWh	720 kWh

The calculation example shown above involves a sealing station with a production speed of 60 stand-up pouches per minute. Here, heat sealing requires an average of 0.5 kW of power per hour. Since ultrasonic sealing modules do not need to heat up and only use energy where it is actually needed, the energy consumption of approx. 0.075 kWh is significantly lower than for heat sealing. In addition, only a small amount of energy is consumed by the generator outside the sealing processes, which means that ultrasonic sealing consumes an average of 0.1 kW of energy per hour. In a 3-shift operation, this saves around 10 kWh per day or just under 2,900 kWh per year for 300 production days.

The calculation example shows that energy savings of up to 80 percent are possible when using ultrasonics. The heat sealing station needs to be continuously ran and maintain its own temperature to prevent production faults or rejected pouches because of weak seals. This substantial energy consumption is avoided when ultrasonics is used. Ultrasonics utilizes cold tooling and shorter weld times which lead to energy savings.

5. USE CASES FOR ULTRASONIC SEALING TECHNOLOGY

Sealing with ultrasonics is used in many applications: from stand-up pouches and cardboard packaging to small capsule packaging for coffee. In particular, packaging where a flawless appearance and absolutely tight seals are crucial benefits from the advantages of sustainable sealing technology. You can find an overview of the most common areas of application here.



5.1. FLEXIBLE PACKAGING

With ultrasonics it is possible to safely push product residues out of the seal area, which ensures absolutely tight seal. This significantly reduces the number of leaking packages and increases the shelf life of products in supermarkets.

Ultrasonics provides this advantage for stand-up pouches, chained bags and

⁴ Energy consumption during sealing: 0.075 kWh. Added to this are around 0.025 kWh consumed by the generator outside the sealing processes.

⁵ With a 3-shift operation

⁶ With a use of 300 days a year.

pillow bags, both at longitudinal and transverse joints, in intermittent and continuous applications.

5.2. CAPSULES AND TEA BAGS

Sealing of lid films, welding of seal rings and embedding of filters are the most important applications for which ultrasonic welding provides a solution. The weld tools hold the film in place by means of vacuum. Shelf life and product protection are ensured due to the tools being cold.

5.3. SPOUT, VALVES AND ZIPPERS

With ultrasonics, fast and safe welding of injection molded degassing valves or spouts on films of any type is possible. Film shrinkage is prevented and the barrier properties are not jeopardized since ultrasonics only excites the molecules in the actual sealing layer. Moreover, ultrasonics allows for safe integration of zippers for re-sealable pouches and welding of the zipper ends (zipper-crushing).



5.4. CUPS, BLISTER PACKS AND TRAYS

On PET applications in particular, ultrasonics quickly reaches the high melting point and therefore results in an increase in production output. Sealing and separating blister packs is easily possible, also integration of tear out sections and tamper-evident seals.

5.5. CARTON PACKAGING

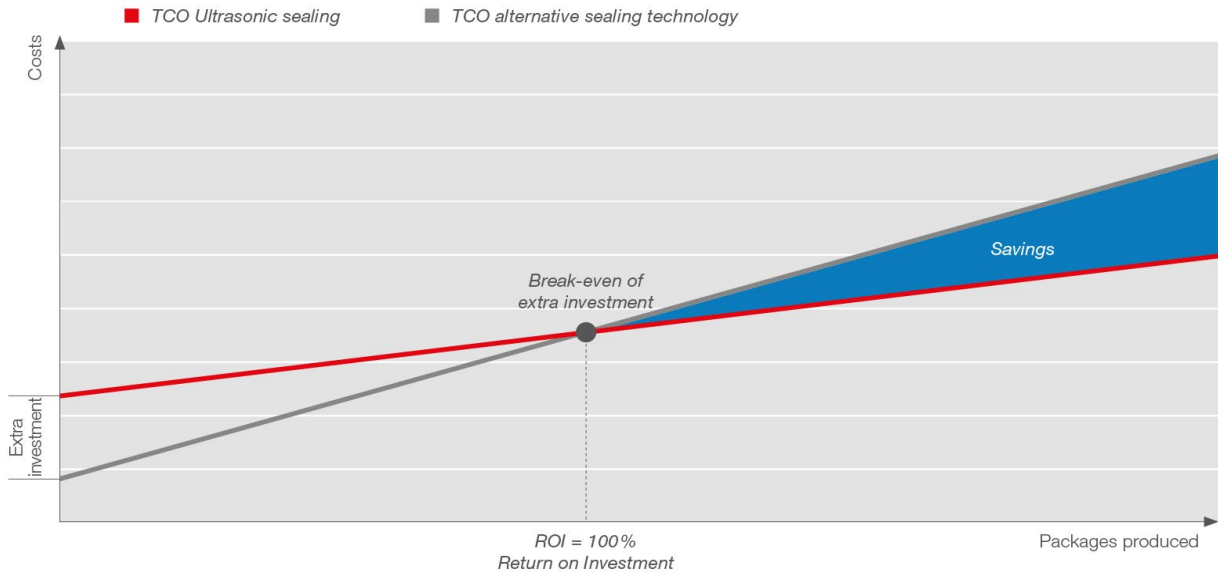
Even if the sealing area contains product during the filling process, tight seals are ensured with or without an aluminum barrier layer. Spouts can be easily integrated into the packaged material and sealed using ultrasonics. Short sealing times lead to higher outputs and repeatable parameters ensure consistently high sealing quality.



6. SUSTAINABILITY CAN REDUCSE YOUR COSTS

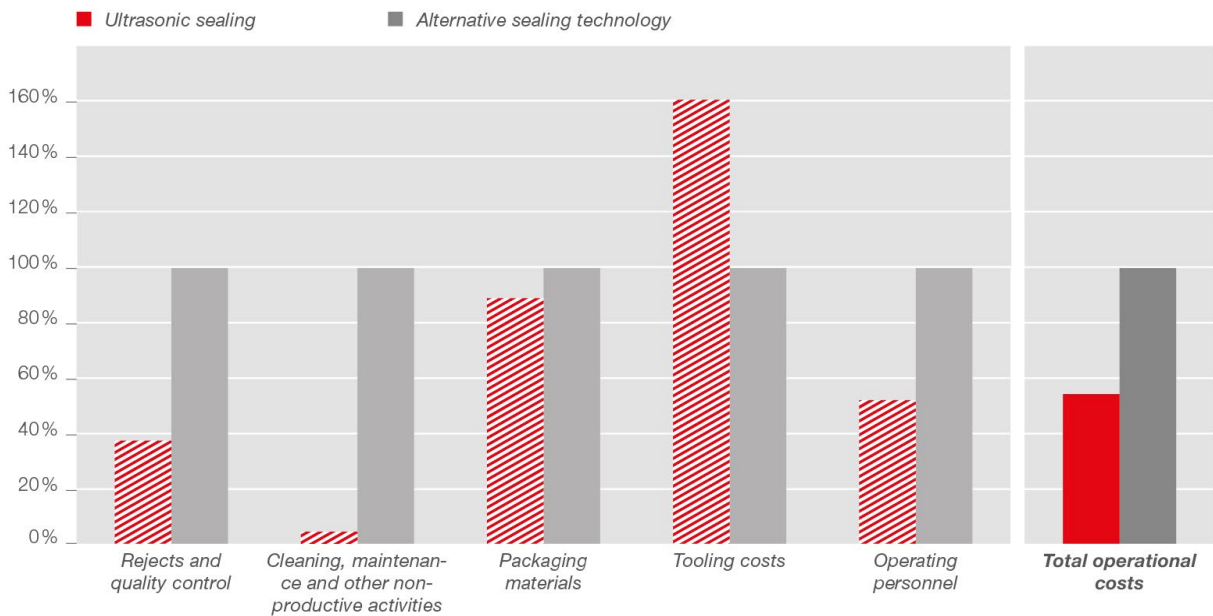
Ultrasonic sealing is a safe, efficient and powerful technology. As such, it not only helps companies become more sustainable, but can also reduce costs in the long run thanks to the reduction of rejects and energy savings. Within a short period of time, the higher investment costs are worthwhile compared to alternative sealing technologies:

Comparison of total operational costs – Total Cost of Ownership (TCO)



The comparatively higher investment costs in ultrasonics sealing technology led to long-term cost savings thanks to its efficiency.

Important components of the total operational costs



Above all, the reduction of rejects and downtimes lead to low operating costs of ultrasonics sealing technology.

7. CONCLUSION

The path to greater sustainability does not have to be complicated, elaborate or even costly. Packaging sustainably can simply mean packaging more efficiently. Ultrasonics can effectively help you achieve your sustainability goals while simultaneously saving on costs. Three decisive advantages ultrasonics offers you are:

- You can process mono-materials
- You reduce your reject rates
- You save energy

For ultrasonics to optimize your packaging process, all components and parameters must be matched to your application – this ensures a reliable process in continuous operation. Thanks to many years of ultrasonic experience, Herrmann knows what factors are important and can support you in making a smooth and uncomplicated transition to ultrasonic sealing technology

With more than 2,000 solved applications per year, we are always at your side as a trusted advisor: from initial sealing tests to integration into the production line and beyond. We ensure you receive a reliable ultrasonics sealing solution that makes your packaging process more sustainable, efficient and safe.

Contact us to start your welding project together! We are there for you – worldwide and in your language.

Have questions? We are here for you!

Robert Hueber and team

+49 7248 79-8383

packaging@herrmannultraschall.com

www.herrmannultraschall.com





IMPRINT

Herrmann Ultraschall
Descostrabe 3-11
D-76307 Karlsbad
Tel. +49 7248 79-0
Fax: +49 7248 79-1039
info@herrmannultraschall.com