Traceability Tools

Single-Serve Evolution

US/China Trade Truce

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Over the years, plastic proprietary capsule systems and Nespresso-compatible plastic alternatives have grown rapidly, now claiming the lion’s share of the global single-serve capsules market. According to a report released by consulting firm AMI International in October 2018, compatibles are now making up about a quarter of the single-serve coffee segment.

“Compostable” is trendy, but...
With the “going green” craze gaining momentum around the world (particularly in Europe and North America), compostable or biodegradable pods are enjoying skyrocketing popularity among consumers. A whole slew of companies, for instance Germany’s BASF and a recently formed joint venture between Japanese firm Mitsubishi and Thailand’s state-owned petroleum company PTT, are either developing or have already rolled out new bioplastics to further supplement the existing range.

Meanwhile, Italian private label coffee company COIND said it was going to launch its first compostable capsule in early 2020, supplying large local supermarket chains like Co-op. However, one issue with the bulk of biodegradable materials remains of course the fact that they are not necessarily “home-compostable”. And “industrial composting” depends on reliable, uncomplicated collection systems for separating used pods from other household waste. Although some initiatives have successfully started to address that problem, the amounts actually collected and recycled this way nevertheless account for just a tiny fraction of the exponentially growing mountain of discarded pods, at least at this point.

From futuristic pods to ultrasonic capsule-sealing, there’s a lot of innovation in the single-serve arena.

Credit: Herrmann Ultraschalltechnik GmbH & Co. KG

Red lines indicate where lids are sealed to pods and filters to capsule bottoms.
An old friend returns

This conundrum has perhaps helped in fostering the re-emergence of an old, trusted friend: aluminum. Martyna Fong, unit manager packaging at AMI International, cited Nespresso as spearheading the move: “Nespresso has put all the efforts in establishing the collection and recycling infrastructure for its used [aluminum] capsules.” She added that “following Nespresso’s open invitation [to the industry] in March 2019 to join in forces in its recycling scheme, more and more capsule manufacturers are considering aluminum as their material of choice and the end-of-life option that it offers.”

Following Nespresso’s lead, other brands that have switched from plastic back to aluminum include L’Or, Café Royal, Dualit, Colonna, and Roastworks, just to name a few. The reasoning behind aluminum’s resurging popularity is sound. “Recycling aluminum uses 95% less energy than producing new one… and it can be recycled infinitely without degradation or loss of quality,” Fong explained. That doesn’t mean that bioplastics and other sustainable materials are on their way out. Far from it. They remain as popular as ever, particularly under the aspect that new, improved plastics continue to be developed all the time. There certainly is nothing wrong with pursuing the topic of single-serve capsules from different perspectives. But if a certain Swiss entrepreneur has his way, the whole industry may soon be turning on its head.

Singaporean innovation, Swiss entrepreneurship

When Pascal Schlittler introducing his latest epiphany, Droops, at a recent AMI seminar, he caused quite a few raised eyebrows and gained thunderous applause for his marvelous flash of genius. Supported by a newly formed joint venture, Droops is the provisionary name given to a rather futuristic type of single-serve coffee pod that is fully biodegradable, contains neither plastic nor metal of any kind and indeed has a fully dissolvable shell! Sounds intriguing? Well, there is more: Droops take the odd shape of an oversized… gumball.

Conceptualized by noted Singaporean industrial designer Eason Chow, Schlittler – recognizing the potential revolution that Chow’s invention could spark– soon teamed up with him and pulled in a number of other investors for the joint venture. “After Chow had presented the idea to me, I was able to share [his] design idea with some investors in Europe, who had the technology at hand that was needed to make Droops become reality. Bringing together these various parties, they all contribute a piece to the Droops puzzle,” Schlittler divulged during an interview with STiR.

Let’s get the ball rolling

The concept of a “soft shell” spherical pod appeared very convincing to everyone involved, also in relation to the specialized coffee maker (see side box) that eventually would constitute another step in development. “A [Droops] capsule rolling into place for coffee extraction opened interesting new ways of addressing the functioning of a traditional coffee maker,” Schlittler mused. But back to the beginning: Schlittler et. al. first had to solve the issue of how to reliably compress coffee grinds into a ball shape.

“As you may imagine, in an industrial process the compressing of coffee powder and conveying it to various other production stages can be a challenge until the balls are hardened and ready for final packaging,” he said. Following numerous rounds of trial and error, the solution was to mix the powder with a certain type of algae and salt. Yes, salt.” But I assure you that it does not affect the taste and aroma of the brewed coffee. An espresso extracted from a Droops ball is just as good as any that I’ve ever tasted in a regular café,” said Schlittler.

A shell named cellulose

That left the question of how to “package” the compressed coffee sphere. The team eventually came up with a fully-organic, liquid cellulose coating which after hardening provides a suitable barrier and prevents oxidation of the enclosed compacted coffee. According to Schlittler, “the shelf life of a Droops pod currently can be compared to that of regular roasted coffee beans.” With further experimentation, it is hoped to eventually raise that shelf life to up to nine months.

The cellulose shell, Schlittler said, also bestowed “a serious advantage to all other single-serve coffee pods made from plastic or aluminum, as we are merely looking at only one single primary packaging component.” Not only that, but the coating material “costs almost nothing.” Additionally, since all Droops components, including the shell, are wholly natural, used pods can simply be thrown on the compost heap or delegated to normal kitchen waste.

Hermann Ultraschalltechnik founder Walter Herrmann demonstrates the ultrasonic coffee pod module
A piercing matter

Spherical “Droops” capsules require a specialized coffee maker, prototypes of which have already been developed by Pascal Schlittler. Vaguely reminiscent of old-fashioned gumball dispensers, they have a holding tank that can be filled with “Droops” pods. When operated, a single pod is released, rolling onto a tray where it lodges and is securely fixed in place by a clamping mechanism.

Subsequently, two large hollow steel syringes will pierce the “Droops” ball from opposite sides, each penetrating the compacted coffee within the cellulose shell. One of the syringes injects pressurized, steaming water, while the other extracts the ready brew into a drinking cup.

The used “Droops” ball, which thanks to the hot water infusion has become soft and malleable at this stage, is discarded into a container and can later be delegated to the compost heap, where it decomposes naturally. It simply doesn’t get any “greener” than that.

Revolution dawning?

However, a market appearance of Droops is not to be expected anytime soon. “A commercial roll-out can probably only happen in about two to three years,” Schlittler assessed in an email correspondence with STIR. Although proof of concept has been ascertained, the team is still working on industrial scalability and validation.

“But in order to scale up - in particular with regards to professional development of a wider product range - the need for an industrial set-up is of utmost importance,” Schlittler said. “Additionally, the convenience aspects the capsule provides, such as easy handling, brewing cleanliness, result in the cup, and very low production cost are great benefits, too.”

Good vibrations

Until the Swiss entrepreneur is ready, we all will have to be content with conventional pods, which are generally characterized by sealed-on lids. In the production setting, this is commonly achieved by heated mechanical jaws. But there is an ingenious alternative: ultrasonic sealing. While that thermoplastic welding technology has already been in use for decades, foremost in the automotive and pharmaceutical industries, it has only relatively recently been adopted by the coffee product sector.

Founded in 1961 and maintaining representations in 20 countries, one of the trailblazers of the technology is German company Herrmann Ultraschalltechnik GmbH & Co. KG. “We have been developing ultrasonic sealing systems for more than 50 years, contributing significantly
Ultrasonically sealed coffee pods

with technical inventions, some of them patented,” said Christin Pörner, one of the firm’s project heads responsible for product management. Still, it was only about 15 years ago when the company realized the technology’s potential for the coffee capsule market, beginning to modify and adapting its systems accordingly. Pörner elaborated that the traditional non-ultrasonic sealing methods deploying can result in “insufficient tightness” when finely ground coffee particles adhere to the capsule rim, compromising the bonding between cup and lid. “But apart from the circumstance that, unlike heated jaws, ultrasonic tools stay cool during the sealing process, they also literally ‘vibrate’ product residues off the sealing area. This ensures a higher percentage of hermetic seals,” Pörner pointed out.

The Swiss... again

Herrmann Ultraschalltechnik began developing its first ultrasonic sealing solution in collaboration with an unnamed “big Swiss coffee company” back in 2005. “A major step was our influence over the development of the capsules used, especially their design, as we incorporated a so-called ‘energy director’, a special contour feature either on the sealing tool itself, called a ‘sonotrode’, or right on the capsule ring surface,” Pörner explained. That “energy director” assures better energy focusing during heat-welding. “But it’s been quite the journey to market this technology and win customer acceptance,” admitted Pörner. Her colleague Michael Zimblerakis, area sales manager for packaging, added that the proof of concept posed a particular challenge. “It wasn’t easy to convince customers that our technology was capable of delivering a 100% tight sealing seam even in the presence of product contamination on the sealing surface,” he said. “However, we eventually succeeded and started building a positive reputation.”

Oscillating benefits

The principle behind ultrasonic sealing is the conversion of electrical oscillation – or high-frequency vibration - into mechanical oscillation. This mechanical oscillation acts on the packaging components to be sealed. It also generates the heat necessary to surface-melt thermoplastic materials, creating a molecular bond, i.e. an absolutely hermetic seal. “In technical lingo, the ultrasonic stack consists of a piezoelectric actor [converter], an amplitude transformer [booster], and the weld tool [sonotrode].

The latter vibrates with a frequency of 20, 30, or 35 kHz per second with an amplitude of 20 to 50 µm. To appreciate that dimension, a human hair has a diameter of about 100 µm,” elaborated Pörner. Because heat is solely generated through oscillation alone, no pre-heating or post-cooling of tools is required, reducing production times and increasing OEE. “These are very important aspects especially in the case of single-serve product manufacturing,” asserted Pörner.

Ultrasonic technology, she continued, was “a great alternative when conventional technology reaches its application limits.” Pörner insisted it could be applied with all thermoplastic materials “as long as there exists an identical sealing layer on both the lid and the capsule.” But she also cautioned that there are certain limitations when it comes to aluminum capsules and lids.

“These cannot be sealed properly [using ultrasonic technology]. However, with the recent trend towards sustainability, companies are all looking for aluminum-free solutions and come knocking on our laboratory doors,” she claimed, somewhat contradicting the observations about a resurgence of aluminum that was made at the beginning of this article. Nevertheless, Pörner said her company had “achieved very good results in sealing the new types of mono and composite materials the industry wants to use for sustainability reasons.”

Easy integration to venture into a new era

Ultrasonic systems can easily be integrated into existing packaging lines. “We deliver customized ultrasonic stacks for mechanical integration as well as the generators for electrical integration,” Pörner said. The generator communicates with the machine’s PLC, monitoring and controlling the entire sealing process. Operators receive detailed quality information, including seam leakage alerts. The sonotrode of the equipment stack is customized to the customer’s capsule design, determined and developed in the course of feasibility and material tests at Herrmann Ultraschalltechnik’s in-house lab.

“We have executed many successful OEM integrations and also have retrofitted numerous existing lines,” Pörner claimed. And while she conceded that ultrasonic technology at the moment only serves a niche market as far as sealing of single-serve capsules is concerned, she also pointed out that the method was capable of supporting “a number of other packaging solutions for portioned coffee and tea as well,” such as sealing of adapter rings and the welding of filters to inner capsule walls, to name but a couple of possibilities.