SML TECH REPORT

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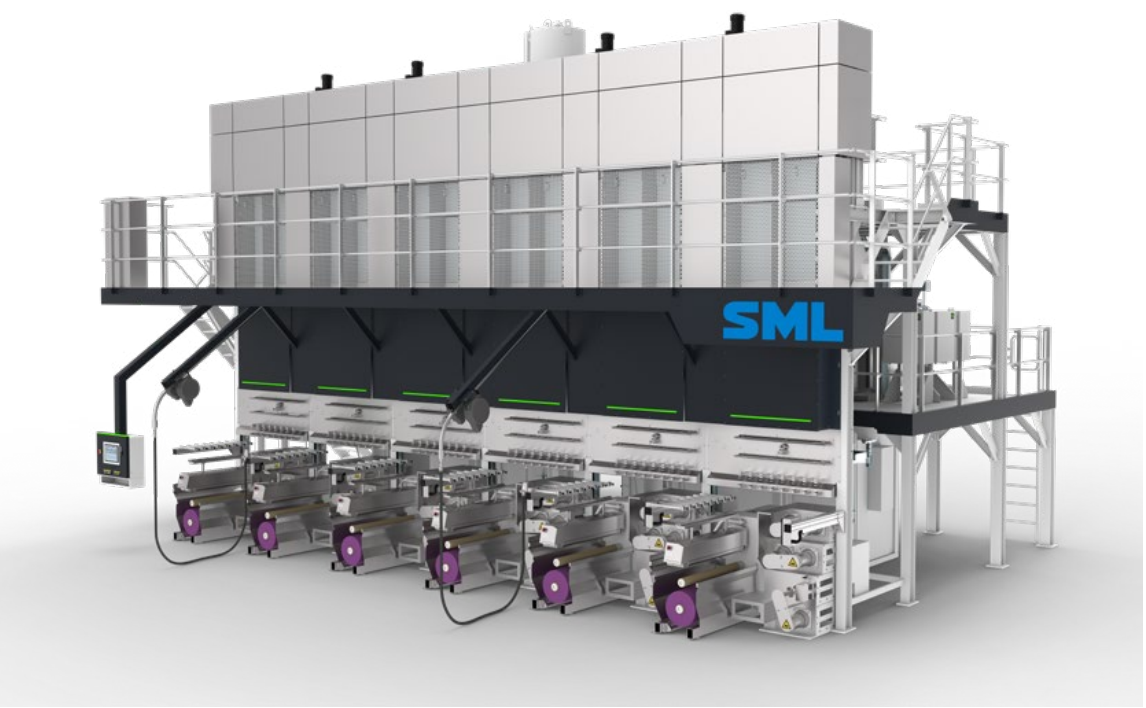
Higher output at lower titres:

Austrofil® "VERTEX" spinning line for PP and PET yarns



With its focus on the lower titre range, SML's new VERTEX-series is a perfect addition to SML's top-selling Austrofil® MT/HT multifilament spinning lines. Its key characteristics are higher line speeds, increased output capacity and more efficiency at low titres. At ITMA 2023, the new series will be presented to the wider public.

In contrast to SML's market proven Austrofil® MT/HT 4x4 spinning lines with 16 yarn ends, the new Austrofil® VERTEX line exhibits 24 ends in its basic configuration 3x8. Therefore, the line efficiency is substantially increased at low titres. To give an example: the production output for a 250 den yarn is doubled than on the Austrofil® MT/HT line. Apart from the higher number of yarn ends, the VERTEX line is equipped with godets and winders for increased speeds.

MODULAR LINE CONCEPT – FLEXIBLE ENLARGEMENT

With the new VERTEX series, SML is presenting a completely new line concept: the stretching and winding units of the VERTEX series are placed directly beneath the spinning head and the quenching unit. Therefore, a VERTEX 3x8 requires 30 % less floorspace compared to an Austrofil® MT/HT 4x4. Additionally, this "line-by-line" concept offers the possibility to enlarge production capacity by simply adding further spinning units. This is accomplished by a sophisticated steel construction, which makes it possible to easily string together additional machines of this type.

READY FOR PET

The application area of the new VERTEX series will not be limited to PP. Instead, it will be extended to PET in response to the market requirements for PET CF yarn. This type of PET yarn will find applications in various areas, for example, in the manufacturing of air texturising yarns, yarns for carpet piles or yarn for home textiles and upholstery. In this context, the Austrofil® VERTEX line will cover a titer range from 75 to 800 den.

Comparing a standard Austrofil® MT 4 x 4 line with the new Vertex 3 x 8 line at 250 den

Line type	Austrofil® MT 4x4	VERTEX 3x8
Material	PP	PP
Titre [den]	250	250
Extruder	1x75/28	1x75/28
Production output [kg/h]	80	160
Winding speed [m/min]	3000	4000
No. of ends total	16	24
Dimensions (LxWxH)	11.1 x 7.2 x 6.0	8.8 x 6.4 x 7.9

LONG-TERM EXPERIENCE

SML has long-term experience in the manufacturing of spinning lines for premium MT and HT yarn. Today, over 200 Austrofil® MT/HT lines are in operation, manufacturing in a wide range of different products such as sewing yarns for big bags or synthetic yarns for ropes, filters, belts, carpets, seals, and many other textiles. Generally, these top-selling Austrofil® lines cover a titre range from 150 to 4,000 den, but their focus – and optimum efficiency – lie in the range between 600 and 2,000 den. Maximum tenacity can be achieved in its HT configuration, with the unique hot-air oven technology.

Editorial

Karl Stöger
Managing Director

Dear Reader,

As the demand for plastic products continues to grow, so does the need for new and innovative technologies in extrusion lines for plastics processing. The further development of these technologies is crucial if we wish to improve the efficiency, performance and sustainability of extrusion processes. In this issue of our TechReport we present some of the latest innovations from SML:

When it comes to cast film extrusion, one of the most exciting new achievements is the ability to use high percentages of PIR und PCR material in stretch film production. By combining recycled and virgin materials in the film structure, manufacturers can support a circular economy and achieve properties exceeding market requirements.

In sheet extrusion, down-gauging is an ongoing trend, and this leads to film thicknesses that are often too thin for the traditional 3-roll calendering process. The casting process for thin PET film, as alternative, can be a good match. Find out the benefits within this issue.

Extrusion coating is another area that has witnessed significant innovation. For one of our recent customers, extensive testing on our FlexPack demonstration line with new coating materials has resulted in products with improved surface properties and enhanced overall performance. A new industrial-size extrusion coating and laminating line will soon be available for trials at the SML Technology Centre.

Finally, our multifilament spinning lines have greatly benefited from advancements made with our VERTEX spinning line: a vertical arranged machine for POY and FDY yarns made either from PP or PET. With the new set-up, an increase in productivity is achieved, especially at low titres.

To put it in a nutshell, thanks to the continuing introduction of advanced extrusion equipment, we can look forward to a more sustainable, efficient, and productive future for plastic extrusion.

Yours faithfully,

Teaming up for innovations

Highly advanced *FlexPack*® extrusion coating line in SML's Technology Centre

SML's new state-of-the-art demonstration line for extrusion lamination comes in a new design and features a number of technical innovations

Effective product development is a key success factor in the fast-changing market for extrusion coated materials. SML continuously prepares its pilot and demonstration lines for R&D efforts. From 3rd quarter 2023 onwards, a completely new production scale *FlexPack*® extrusion coating and laminating line will be available in SML's Technology Centre for performance tests and product development.

SML's new state-of-the-art demonstration line for extrusion lamination comes in a new design and features a number of technical innovations: The plant is equipped with three extruders, that are configured to process a huge variety of different polymers - ranging from polyolefins to TPU, TPE, PET, PLA and EVOH. To increase the output range for certain materials, the main extruder's drive power had been raised to reach screw speeds up to 425 rpm. A Smart Drain unit supports fast and efficient polymer change overs. Melt homogeneity can be observed via an Infrared Line Scanner, that constantly measures the temperature profile in the melt curtain.

BARRIER COATING AND ULTRA-THIN MEMBRANES

The co-extrusion feedblock provides up to five layers, which enables the production of barrier-coated film for flexible packaging. Apart from two automatic unwinds, the new line is equipped with an additional single unwind for the production of reinforced laminates. Fitted with the patented DoubleCoat technology, the new plant also offers the functionality to create ultra-thin breathable membranes. They are applied above all in the construction industry, for functional clothing and for a wide range of different hygiene applications.

BEST PRACTICE: CUSTOMER DEVELOPS AT SML

"Manufacturers of laminates, membranes and composites frequently use the demonstration lines in our Technology Centre and benefit from our understanding of process technology, when it comes to the creation of new products or the optimisation of production processes", Johannes Danter, Product Manager at SML, explains.

One excellent example of a successful long-term partnership in a product development process is most definitely the cooperation between Dörken GmbH & Co KG, a well-known German manufacturer of construction materials, and SML. When Dörken developed its latest generation of highly permeable roof and façade membranes, substantial parts of the development process were realised in SML's Technology Centre.

GENERATING KNOW-HOW – ACCELERATING DEVELOPMENT PROCESSES

The joint R&D efforts went on several years: Among other things, these encompassed basic trials with the SML DoubleCoat process, test series with the most important products of Dörken's portfolio and several test runs for the development and sampling of new roofing membranes.

As a result of this R&D project, SML developed two extrusion lamination lines that are 100 % tailormade for the purposes of Dörken. Since it was possible to certify a number of products even before the new lines were commissioned, the over-all product development process was accelerated quite significantly. "In principle, we have actively integrated SML's plant into our Stage Gate process," Christian Harste, CTO at Dörken, clarifies. Immediately after the installation of the two lines at Dörken, the company was able to start regular production. "We consider this successful product development project as a prime example for future cooperations", SML Product Manager Johannes Danter concludes.

New cast film line in SML's Technology Centre

A new, state-of-the-art cast film line with an integrated MDO unit will be available for customer trials and joint R&D efforts at SML's headquarters by mid of 2023.

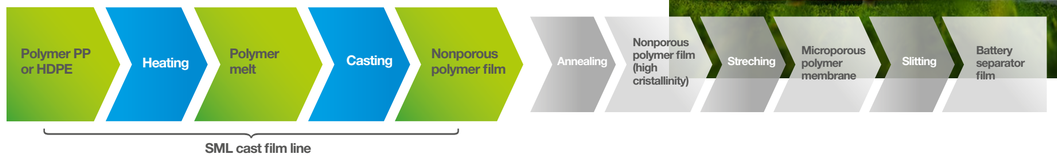
The industrial-scale pilot plant will be ready for the production of CPP, CPE, Cast-PET, Barrier, MOPP, MOPE and MOPET film. It has the following technical features:

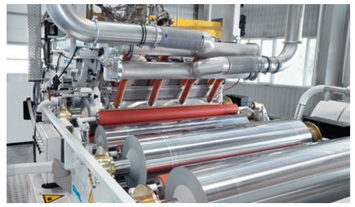
- Five extruders for the processing of PP, PE, PA, PET, EVOH, as well as a tie-layer
- A seven layer feedblock with a variable geometry and the possibility of a different layer distribution
- Die width 2,850 mm; final film width of cast film: approx. 2,400 mm; final film width of mono-axial- oriented film: 2,200 mm – depending on the raw materials and process parameters
- MDO unit: maximum roll temperature 160 ° C, maximum stretching ratio 1:10
- Horizontal sliding winder for up to 4 part bobbins

For further information on the line's technology, its capacities or the possibility to conduct customer trials or joint R&D, please contact: Alexander Bruckmüller, bra@sml.at

Separator film for lithium-ion batteries:

Quality claims and production methods





With the expansion of electromobility, the market for lithium-ion batteries is gaining rapidly in importance – and with it the demand for separator film. This is one of the most critical and expensive part in a li-ion battery, accounting for 15 – 20 % of the overall costs.

"In the last 10 years, SML has delivered more than 90 cast film lines for the production of premium separator film, using the efficient and environmentally friendly dry process. With this vast experience gained, we know in the meantime what really matters in this business," Alexander Bruckmüller, Product Manager at SML explains. But which functions does a separator basically have in a lithium-ion battery? Its main purpose is to keep the two electrodes apart to prevent electrical short circuits. Simultaneously, the separator allows the transport of ionic charge carriers that are needed to close the circuit during the passage of current in an electrochemical cell. To fulfill these functions, separator film in lithium-ion batteries must meet a number of requirements:

- **Free from gels,** as any surface defect, unmolten or burnt particle in the film can cause holes after stretching. And this in turn causes short circuits.
- **Thin-gauges and uniform thickness:** Battery separator film (BSF) must be thin to facilitate the battery's energy and power densities. To support many charging cycles, its thickness must be uniform.
- **Optimum porosity** enables the electrolyte to be thoroughly moistened and ensures facile ionic conduction. Generally, commercial separators with pores of 1 µm or less have a porosity of 40 – 50 %.
- **Adequate mechanical properties,** to withstand physical stress caused by external compression and electrode expansion.
- **Chemical stability:** The separator must be an electronic insulator, additionally it must be electrochemically stable in the face of redox reaction potentials.
- **Ability for a thermal shutdown** at temperatures that are slightly lower than that, at which thermal runaways occur. During a shutdown, mechanical properties must be retained.
- **Dimensional stability –** the ability to keep shape over a wide temperature range without curling or warping, lying completely flat. Minimum thermal shrinkage in all directions.

COST-EFFICIENT MANUFACTURING USING THE DRY PROCESS

SML's cast film lines for separator film fulfill these requirements one hundred percent. "Separator film can be made of different materials and can be produced in different processes. The most common processes are the dry and the wet process, and the most common raw materials are polypropylene and polyethylene", Alexander Bruckmüller, Product Manager Cast Film Extrusion of SML, explains. On SML's cast film lines, separator film is manufactured using the dry process. Compared to the wet production method, the dry process has significant advantages:

- **Lower material costs:** In the dry process, rather standard PP or HDPE resins are used. While in the wet process, relatively expensive, ultra-high molecular weight polyethylene UMWPE is applied.
- **Fewer production steps:** The dry process is more straightforward compared to wet process.
- **More environmentally friendly:** No solvents are required to create the pores, as it is necessary in the wet process.
- **Much lower energy consumption –** it is not necessary to evaporate the solvent and dry the film afterwards.

Next to the electromobility market, dry process separator film is in high demand for large-scale electricity storage at wind and solar power plants.

Thin PP and PET film for thermoforming:

Casting might be the better option!

Traditionally, PP and PET film for thermoforming applications such as for trays or lids, is produced on calendering roll stacks. However, now that demand for lighter and more resource-saving packaging materials is on the rise, the manufacturing of thin thermoforming film using a cast process is gaining in importance. Compared to the calendering process, cast offers a number of tangible advantages:

"On a cast film line, we can achieve significantly thinner gauges than when producing thermoforming film on roll stacks," Rupert Becker, Product Manager at SML, explains. Generally, it becomes more and more difficult to produce PP film thinner than 350 microns or PET film thinner than 150 microns with a calendaring process, due to the mechanical conditions involved. With cast film technology, however, this is a different story since even films with a thickness of 100 microns or less can be manufactured without difficulties.

SIMPLE AND EFFICIENT PROCESS

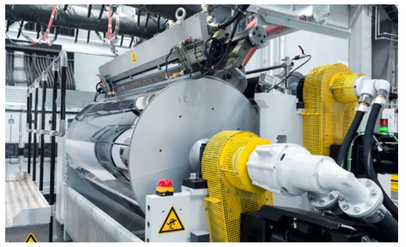
To sweeten the story, the cast process offers other additional benefits especially when it comes to the production of PP films below 350 microns: While it may take hours to adjust a roll stack for the production of thermoforming film of optimum thickness, the start-up of a cast film line is rather simple – involving a minimum of time and material waste. Product changes can also be easily implemented, i.e. when recipes or film thicknesses are modified.

OUTPERFORMING MECHANICAL FILM PROPERTIES

Cast film has a lower internal stress and is more flexible than calendered film. When it comes to shrinkage, it outperforms film manufactured on roll stacks with ease. This makes cast film a good choice to be further processed in thermoforming applications, where the film is heated and formed into a specific shape.

HIGHER FILM WIDTHS AND PRODUCTION SPEEDS

In a cast process, film widths of more than 2,400 mm are possible. In contrast, calendering roll stacks with widths of more than 2,400 mm and for thin film gauges are extremely seldom – and limited due to physics. Machine production speeds up to 150 m/min can be realised for casted film for thermoforming applications when fully automatic winders are used. As an example, SML's W2000 winder is optimally suited for these speeds and for in-line slitted rolls.



ONE GLOSSY SIDE, ONE MATT SIDE

"A product difference between casted and calendered film for thermoforming is that cast film always has one matt side, due to the use of air knives in the production process. This might be critical in some applications. However, at many applications it is hard to understand, why so many manufacturers still stick to the calendering process", Rupert Becker comments.

ALWAYS THE OPTIMUM SOLUTION

SML has more than 30 years of experience in developing and constructing state-of-the-art calendering lines, cast film lines as well as combined systems. "Our machinery basically caters for all the requirements in the field of thermoforming film. It is always our utmost aim to provide our customers with optimum solutions to help them achieve competitive advantages," SML's Product Manager, Rupert Becker, concludes.

PCR in stretch wrap film

Making stretch film more sustainable

With success, SML recently demonstrated the industrial scale production of high-performance stretch film containing 30 % post-consumer recycled (PCR) resin on its PowerCast XL line. This breakthrough in the use of PCR resin proceeded several years of extensive R&D efforts. SML TechReport talked with Doris Eberhard, R&D Manager at SML, about the current state of affairs, the obstacles that had to be overcome to reach market-ready qualities and future prospects.

SML TechReport: How ready is stretch wrap film that contains PCR for today's markets?
Doris Eberhard: "Let me say that SML is ready to provide our customers with 100 % ready-to-use solutions. Today, we are able to deliver machinery that can manufacture stretch wrap film from 30 % PCR in PowerQuality, something which was inconceivable a few years ago. With this proportion of PCR, we are reaching an ultimate over 400 % on 23 microns and an ultimate over 300 % on 15 microns, measured at FPT 750. This comes very close to stretch film from 100 % virgin material! Film of this quality can be easily used in a wide range of applications, either as standard hand or standard machine film. Apart from PowerQuality stretch film, we successfully manufactured stretch wrap film on our lines with a proportion of PCR up to 60 %."

When did you start research into the processing of PCR?
Doris Eberhard: "At SML, we have been working on technologies to process post-industrial recycled resin (PIR) and post-consumer recycled resin (PCR) for many years. Generally, there is nothing new about producing stretch film with PIR. Stretch film manufacturers, who own recycling machines, have been doing this for a long time – typically with a PIR proportion of between 5 – 30 %. But in 2015 we pushed the envelope successfully and manufactured 80 % PIR film of a high quality on an industrial scale stretch wrap line. In 2018, we finally joined forces with different raw material producers and recycling companies to find solutions for PCR-based stretch wrap films."

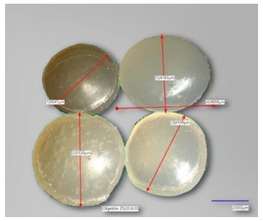
Doris Eberhard analysing the film quality of PCR based stretch film

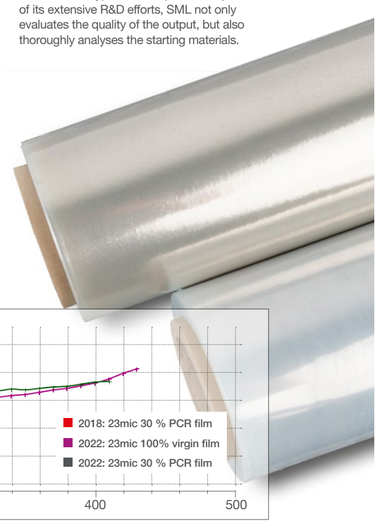
What were the main obstacles on your journey to develop marketable film from PCR?
Doris Eberhard: "It became clear to us right at the very beginning, that producing PCR based stretch wrap film of acceptable qualities is much harder than with PIR. You have to pay attention to a lot of influencing parameters such as: the barrel / screw design, the filter and filter screen, the encapsulation, the PCR quality and amount and a lot of process parameters. At our first trial in 2018, the 23 microns stretch film we produced had only an ultimate of 100 % - which was anything but promising."

So how did you then proceed?
Doris Eberhard: "Well, quite simply, with a huge number of further tests. From 2018 to 2022 we conducted more than 100 different PCR trials in our Technology Centre. On the one hand we changed the line configurations, i.e., on the extruders, the layers or the filters. On the other hand, we varied the PCR types, qualities and amounts, as well as the formulations, film thicknesses and different production parameters. At the end, we produced more than 1,000 sample rolls with PCR inside, which we carefully examined in our lab. Until now, we have conducted more than 1,000 FPT tests and more than 1,000 wrapper tests. Finally, we succeeded and found a way, to manufacture high-quality stretch wrap film from up to 30 % PCR – with nearly no differences to virgin materials."

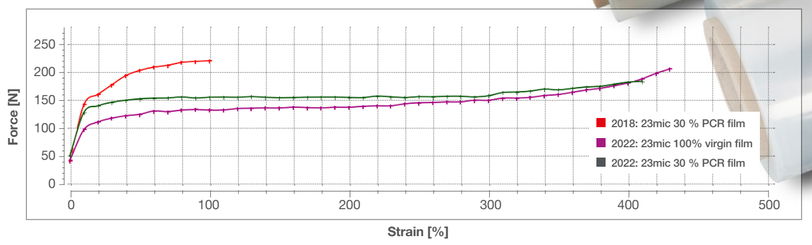
So what comes next – what are the prospects for the future?
Doris Eberhard: "We are absolutely positive that PCR will become an integral part of the stretch film product group in the near future. Some countries like Spain or the UK have already implemented financial incentives for manufacturers who use a certain amount of recycled content, and it is very likely that other nations will follow suit. But to support the usage of PCR, it will be necessary to make a difference in the classification between PIR and PCR. If there is no difference, PIR will be probably favored at the expense of PCR. Apart from that, the quality of PCR resins has greatly improved during the last years, and we anticipate that this trend will continue. That in turn supports the development of new processes for a higher proportion of PCR."

And what are the next steps for SML?
Doris Eberhard: "In the middle of this year, our new lab line "SmartCast Infinity" will be available for more PCR tests to answer the question as to how far we can go in the future."


Four different types of PCR pellets: As part of its extensive R&D efforts, SML not only evaluates the quality of the output, but also thoroughly analyses the starting materials.



Comparison of ultimates at various trials



Events 2023

Event	Location	Booth No.	Date
Plastpol	Kielce, Poland	Stand No. D-8	23. - 26.05.2023
Propak Ghana	Accra, Ghana	Stand No. K02	06. - 08.06.2023
Plast Expo Morocco	Casablanca, Morocco	Stand No: G1A	07. - 10.06.2023
Itma	Milan, Italy	Stand No. H1 E104	08. - 14.06.2023
Saudi PPPP	Riyadh, Saudi Arabia	Stand No. 3-111	12. - 15.06.2023

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