Polymer Modifiers

Small additions, great effect

Portfolio of soft polyolefins: Queo™ POP and POE, EVA and Soft PP for the Compounding industry

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Contents

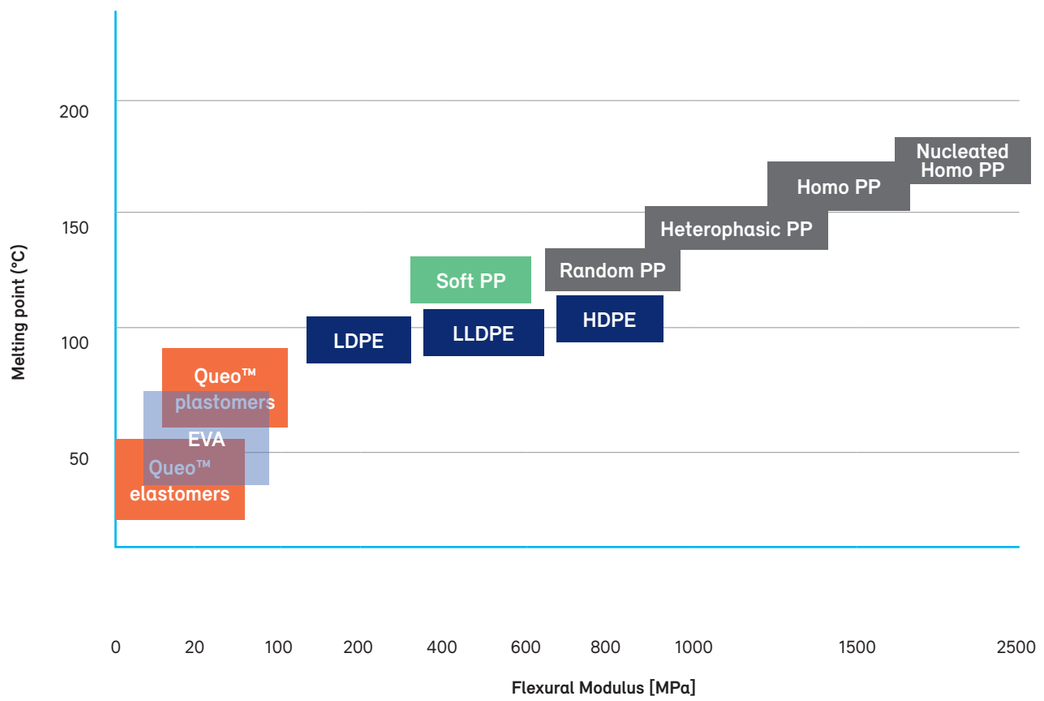
Borealis technologies for Polymer Modification

Creating multiple options in soft and flexible thermoplastic materials ideally suited to modify your polymers into high performing compound solutions

As a leading provider of innovative solutions in the fields of Polyolefins (PO), Borealis continues to develop its portfolio of proprietary technologies and products building on the achievements and experience of more than 50 years in the industry.
With strong roots in Polyolefins, the Borealis portfolio offers a broad range of products for the compounding and polymer modification industries: from PE (HDPE, LLDPE, LDPE) and PP (Homo-PP, Random-PP and heterophasic-PP) resins to specialties like Queo™ Plastomers & Elastomers, EVA and soft heterophasic PPs. Borealis offers a broad toolbox of materials: from very stiff to extremely flexible, as depicted in graph below, allowing a broad range of applications. Furthermore, Borealis can provide many of these materials as Circular and Bio-Circular solutions.

By combining application expertise and leading technologies with a team dedicated to the compounding and polymer modification industry, Borealis offers solutions designed for the best performance in the end-use applications. This is achieved by understanding and interpreting the needs of the value chain from polymer to end user, resulting in the translation of customer requirements into polymer structures and ultimately into innovative products.
Our dedication to Value Creation through Innovation in all applications is proven through the constant development and expansion of our portfolio. Ongoing innovation is crucial to maintaining partnerships that yield long-term success for both Borealis and our customers.

Melting Point vs. Stiffness (Flexural Modulus) for a wide array of PO materials



Queo™

Embedded in the Borealis Plastomers product family since March of 2013, Queo™ is a key brand in our ongoing drive to be a global provider of innovative solutions in Polyolefins.

Queo™ plastomers and elastomers close the gap between classic thermoplastic products and rubbers, exhibiting both plastomeric and elastomeric properties. This is achieved through efficient and uniform incorporation of "1-Octene" as comonomer and by using a specialised metallocene catalyst.

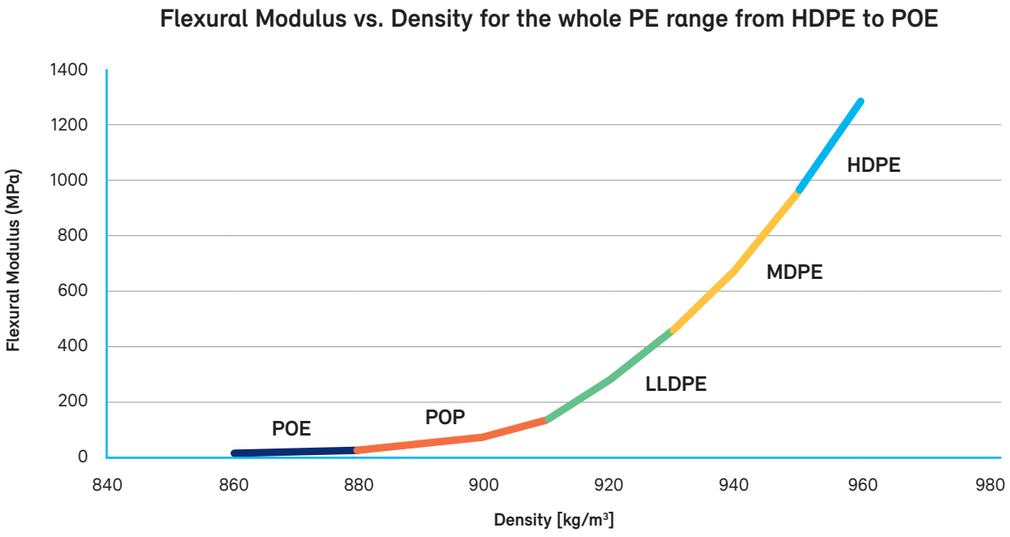
Queo is closing the gap between thermoplastic products and rubbers

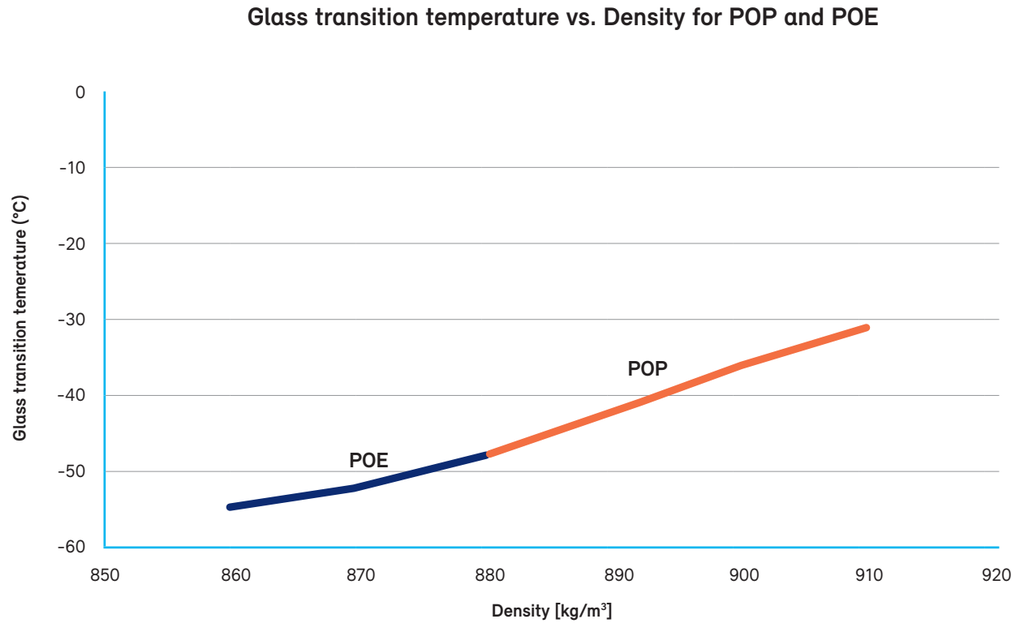
		Polyolefin Elastomers (POE)		Polyolefin Plastomers (POP)			
Density (kg/cm^3)	ISO1183	860	870	880	890	900	910
DSC Peak melting point (°C)	ISO11357	45	60	75	85	95	105
Flexural modulus (MPa)	ISO178	5	10	20	40	70	130

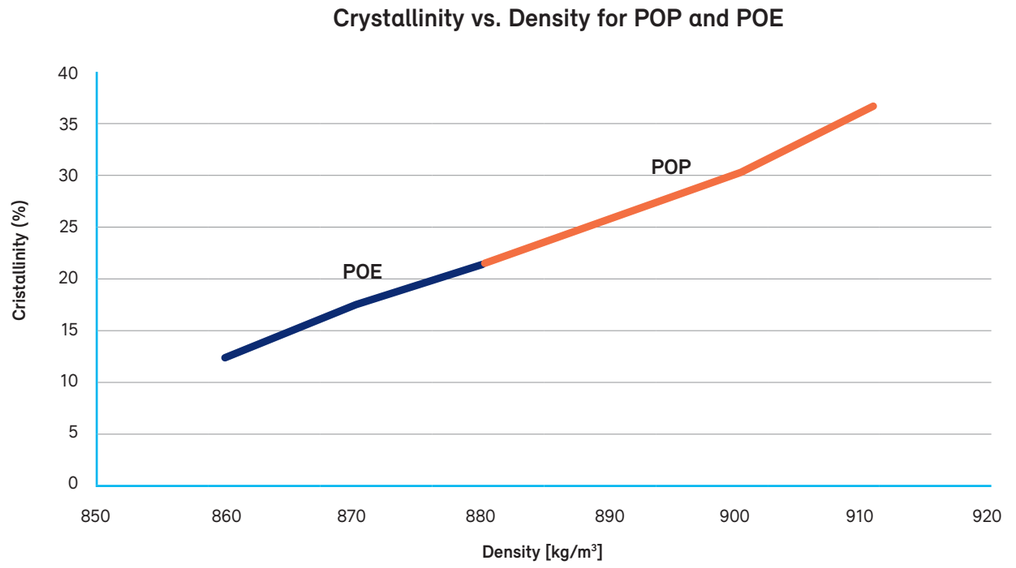
Table 1: Table showing the relation between Density, Melting Point and Flexural Modulus of POEs and POPs.

By incorporating increasing amounts of "1-Octene" comonomer into the ethylene backbone structure, Borealis is able to supply Queo solutions that provide our customers with significant benefits:

- Weight reduction
- Flexibility and softness
- High impact properties
- Low temperature characteristics
- High filler acceptance
- Exceptional sealing performance
- High transparency







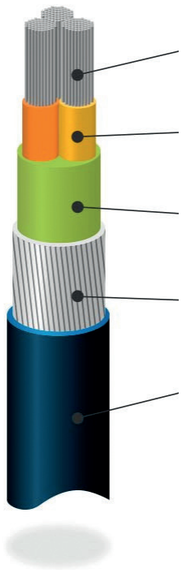
Queo™ Applications

Queo™ Plastomers

The Borealis Queo™ polyolefin plastomers product family offers a unique combination of flexibility (Flexural Moduli 20 - 120 MPa) and high mechanical strength (tensile strength, tear and puncture resistance). Their properties make Queo plastomers suitable for a large variety of applications, including soft flexible mouldings, specialty compounds for a vast number of end uses like automotive TPOs, wire and cable and use as polymer modifier.

Queo™ Elastomers

Whereas Queo polyolefin plastomers are mainly aimed at applications requiring good to moderate flexibility combined with higher thermal properties and high mechanical strengths, Queo polyolefin elastomers target applications for which very high flexibility (<20 MPa) and improved low temperature performance (glass transition down to -55°C) are key requirements. The increased product performance of Queo polyolefin elastomers, compared to polyolefin plastomers makes these products the material of choice for applications such as compounds for interior and exterior car parts, adhesives, cable compounds, grafted polymers and highly resilient surfaces.



Examples of Wire & Cable bedding compounds made using Borealis dedicated flexible Queo™ and EVA grades.

Figure 1

Queo™ Applications
in Polymer Modification

- **Halogen Free Flame Retardant compounds:** Cable bedding compounds
- **TPO applications:** Interior and exterior car parts, appliances and housewares, furniture, recreational goods, crates and containers
- **Adhesive applications:** Hot Melt Adhesives for hygiene and packaging applications
- **Wire & Cable applications:** Insulation, jacketing
- **Other examples:** Grafted polymers, soft foams, flooring

Figure 2: Multiple examples of the use of Borealis Queo™ in bumpers, door panels, suitcase mouldings, castor wheels, shoe soles.

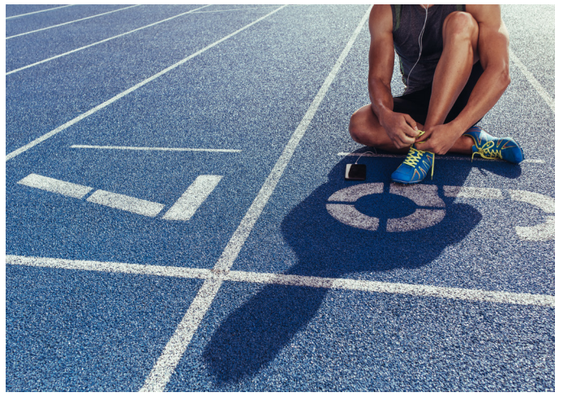


Figure 3: Example of Borealis Queo™ used in resilient flooring granules for an athletic running track.

Figure 4: Example of a Borealis Queo™ utilized to modify the properties of Hot Melt Adhesives.

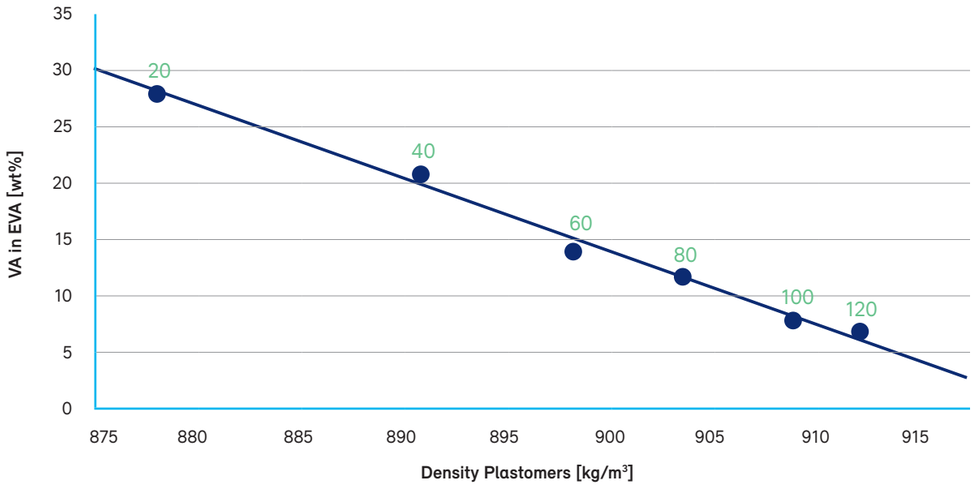
Ethylene Vinyl Acetate (EVA)

Ethylene vinyl acetate copolymers (EVA) are thermoplastic copolymers produced in a high pressure process, comprising units of ethylene and vinyl acetate comonomer.

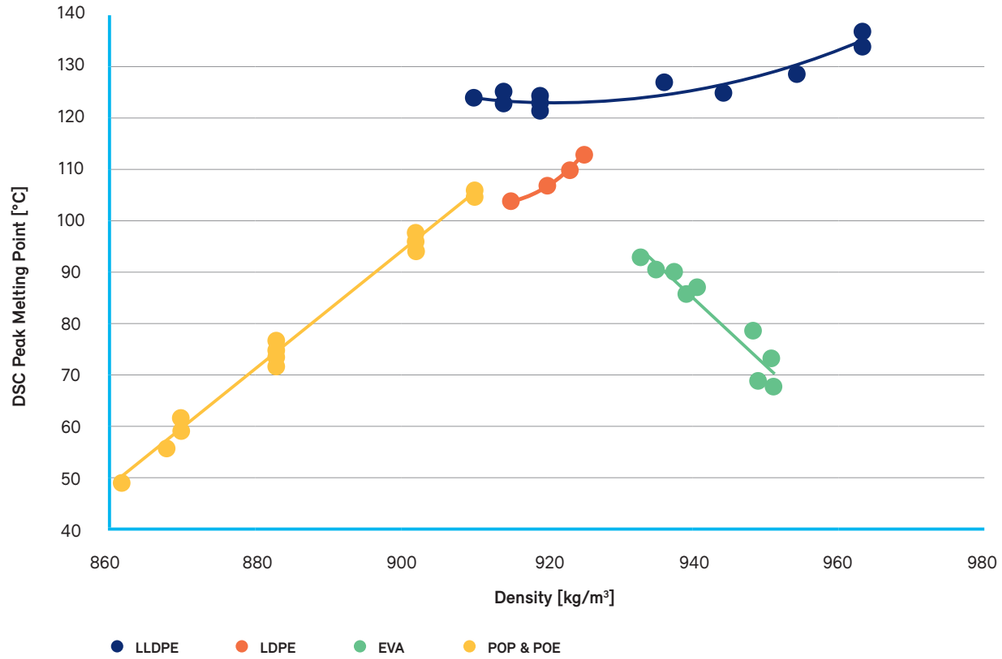
EVA is a more flexible product than standard polyethylene; the flexibility being directly proportional to the vinyl acetate (VA) content. The addition of vinyl acetate co-monomer suppresses the cystallinity of the PE (leading to flexible polymers) and adds polarity. The vinyl acetate co-monomer also raises the density of the EVA and therefore changes the relation between density and flexibility that exist for Queo™. In below graphs the relation between Queo plastomers density and vinyl acetate content in EVA at equal Flexural Modulus, and the relation between density and DSC peak melting points of Queo POP & POE, LLDPE, LDPE and EVA are given.

Plastomer density vs. VA level in EVA at equal Flexural Modulus

Modulus values shown in graph as numbers (in green)



DSC Peak Melting point Plastomers, Elastomers, LLDPE, LDPE and EVA



EVA Applications

EVA is, like LDPE, known for easy processing and melt strength, but additionally provides extra flexibility and compatibility. Polar vinyl acetate groups in the polymer composition raise the polarity and thus improve the adhesion performance to various substrates; the adhesion being directly proportional to the vinyl acetate content.

EVA copolymers can be used in moulding applications (caps & closures), shoe sole (foam) and automotive (sound insulation). EVA polymers are the basis of Hot Melt Adhesive (HMA) formulations and wire and cable compounds.

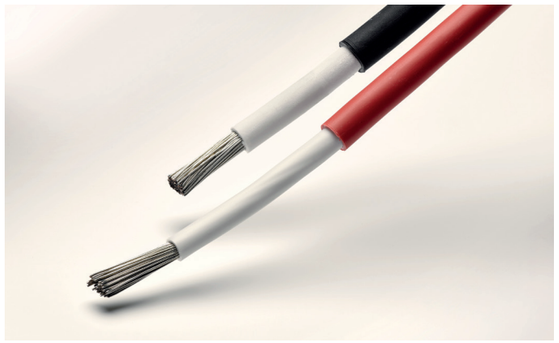


Figure 5: Example of Wire & Cable flame retardant compounds made from Borealis EVA grades.

EVA Applications
in Polymer Modification

- **Building and Infrastructure:** Bitumen modification
- **Consumer products:** Shoe soles, cap & closures
- **Wire & Cable compounds:** Bedding compounds

Soft Random Heterophasic PP

New soft PPs of Borealis

Polypropylenes (PP) can be divided into homo polymer PP (only propylene is polymerized), block or heterophasic copolymers (propylene and some ethylene is polymerized in separated phases leading to improved impact performance), random PP (propylene and some ethylene is polymerized in one phase leading to improved optical performance) and random heterophasic PP (a combination of random and heterophasic PP). The latter can be produced as flexible product with low Flex-Modulus while retaining high thermal stability.

Until now, there have been few suppliers of the lowest Flex-Modulus heterophasic PPs (soft PP). This sort of flexible material is used in a large variety of applications, among which: compounds for flexible membranes for single ply roofing (waterproofing) or automotive applications. In these applications, the softness of the PP needs to be adapted to a level suitable for the applications. Typically, much softer polymer modifiers like PO plastomer & elastomers are blended to achieve the required level of softness for these applications; the stiffer the starting PP, the more polymer modifier needs to be used.

Borealis' range of Soft Random Heterophasic PP helps you optimise your compound, as these materials can be used with less need for polymer modification. Our soft PPs are excellent starting materials for those applications requiring flexibility and high thermal stability like TPO compounds for roofing membranes or automotive interior foils.

Benefits

- Allows benchmark TPO production in automotive and construction industries.
- Provides customers with an alternative option when sourcing soft PP.
- Outstanding low temperature impact combined with high heat resistance/high melting point.
- Broad portfolio of soft PP ranging from Flex-Moduli 550 to 330 MPa and MFR (230°C/2.16 Kg) from 0,8 to 7 g/10 min.
- Excellent starting resins for soft TPOs for flexible membranes.

Soft PP Applications

Borealis soft PPs are used in the formulations of soft compounds in a broad range of applications such as; building and construction applications (flexible membranes / single ply roofing), automotive applications (interior and exterior compounds) and technical items (footwear). TPO single ply roofing compounds benefit from the flexibility, mechanical performance, sealing characteristic and compatibility with other TPOs. These materials are used in the Automotive industry for their unique combination of flexibility, temperature resistance, cold impact resistance and aesthetics.

Figure 6: Example of use of Borealis soft PP grades in flexible membranes and single ply roofing membranes.

Soft PP in Polymer Modification

- **Building and construction:** Flexible membranes, single ply roofing compounds
- **Automotive:** Soft skins, artificial leather, compounds

Figure 7: Example of the use of soft PPs in Automotive interior foils.

Queo™ – Plastomers & Elastomers portfolio

Product name	Density [kg/m3] ISO 1183	MFR (190°C/2.16 kg) [g/10 min] ISO 1133	Melting Temperature [°C] ISO 11357	Flexural Modulus [MPa] ISO 178	Tensile Strength [MPa] ISO 527	Hardness [Shore A] ISO 868	Hardness [Shore D] ISO 868	Additives*	Main applications
Queo 6201LA-P	862	1	49	4	-	61	16	low AO, talcum dusted	TPO
Queo 6800LA	868	0,5	57	8	6	74	22	low AO	TPO
Queo 7001LA	870	1	60	8	7	74	21	low AO	TPO
Queo 7007LA	870	6,6	62	8	6	71	20	low AO	TPO
Queo 8201	883	1,1	73	23	23	85	31	AO	Compounds, Film
Queo 8201LA	883	1,1	75	23	23	85	32	low AO	Compounds, Film
Queo 8203	883	3	74	24	22	85	30	AO	Compounds, Film
Queo 8210	883	10	75	24	13	84	28	AO	Compounds, Film, Moulding
Queo 8230	883	30	76	22	7	83	25	low AO	TPO, Compounds, Adhesives
Queo 0201	902	1,1	97	72	36	>90	41	AO	Film, Compounds, Moulding
Queo 0201FX	902	1,1	95	68	33	-	-	AO, slip & AntiBlock	Film
Queo 0203	902	3	96	72	31	>90	43	AO	Film, Compounds
Queo 0207LA	902	6,6	96	77	22	>90	34	low AO	Film, Compounds, Moulding
Queo 0210	902	10	97	65	14	>90	38	AO	Film, Compounds, Moulding
Queo 0210LA	902	10	96	65	16	>90	38	low AO	Film, Compounds, Moulding
Queo 0219	902	19	97	63	13	>90	38	AO	Film
Queo 0230	902	30	97	65	11	>90	38	low AO	Compounds, Adhesives
Queo 1007	910	6,6	105	118	17	>90	43	AO	Film, Compounds, Moulding

Please contact your Borealis Sales Representative for assistance **in identifying and developing the right polymer modifier** for your specific product needs.

Ethylene Vinyl Acetate (EVA) portfolio

Product name	Density [kg/m3] ISO1183	MFR (190°C/2.16 kg) [g/10 min] ISO 1133	Vinyl Acetate Content [%]	DSC Peak melting point [°C] ISO 11357-3	Vicat Softening temperature [°C] ISO 306 - A50	Tensile Stress at break [MPa] ISO 527-2	Tensile Strain at break [%] ISO 527-2	Tensile modulus [MPa] ISO 527-2	Hardness [Shore A] ISO 868	Hardness [Shore D] ISO 868
OE5309	935	2	9	98	75	18	750	64	>90	43
OE5312I	933	3	12	93	70	19	770	55	>90	40
OE5315I	937	2,5	15	90	62	20	780	45	>90	38
OE5515	935	8	15	91	59	16	810	43	>90	37
OE5118I	940	0,7	18	87	62	27	770	38	>90	37
OE5318I	939	2,5	18	86	58	23	830	35	>90	36
OE5518	939	8	18	85	52	17	810	34	>90	34
OE5918	935	150	18	82	43	5	520	29	89	30
OE5325I	948	2	25	79	48	29	830	18	86	33
OE5328I	950	3	28	73	42	29	810	17	83	29
OE5528I	951	6	28	71	43	17	740	38	83	29
OE5828	949	25	28	69	38	10	880	14	81	24
OE5928	951	43	28	69	36	9	860	9	80	22

Soft Random Heterophasic PP portfolio

Product name	MFR (230°C/2.16 kg) [g/10 min] ISO 1133	Flexural Modulus [MPa] ISO 178	Charpy NIS @ 23°C [kJ/m²] ISO 179-1	DSC Peak melting point [°C] ISO 11357-3	Additives*	Main applications
Bormed™ SC820CF	3,9	550	26	141	AO	Cast Film, Flexible membranes, TPO
SA233CF	0,8	500	58	140	AO	Cast Film, Flexible membranes, TPO
SD233CF	7,0	500	11	140	AO/CR	Cast Film, Flexible membranes, TPO
Bormed™ SB815MO	1,5	425	80	145	AO	Moulding, PP Compounds
Bormed™ SC876CF	3,8	330	77	149	AO/CR	Cast Film, Flexible membranes, TPO
SB330CF	1,5	330	80	150	AO	Cast Film, Flexible membranes, TPO

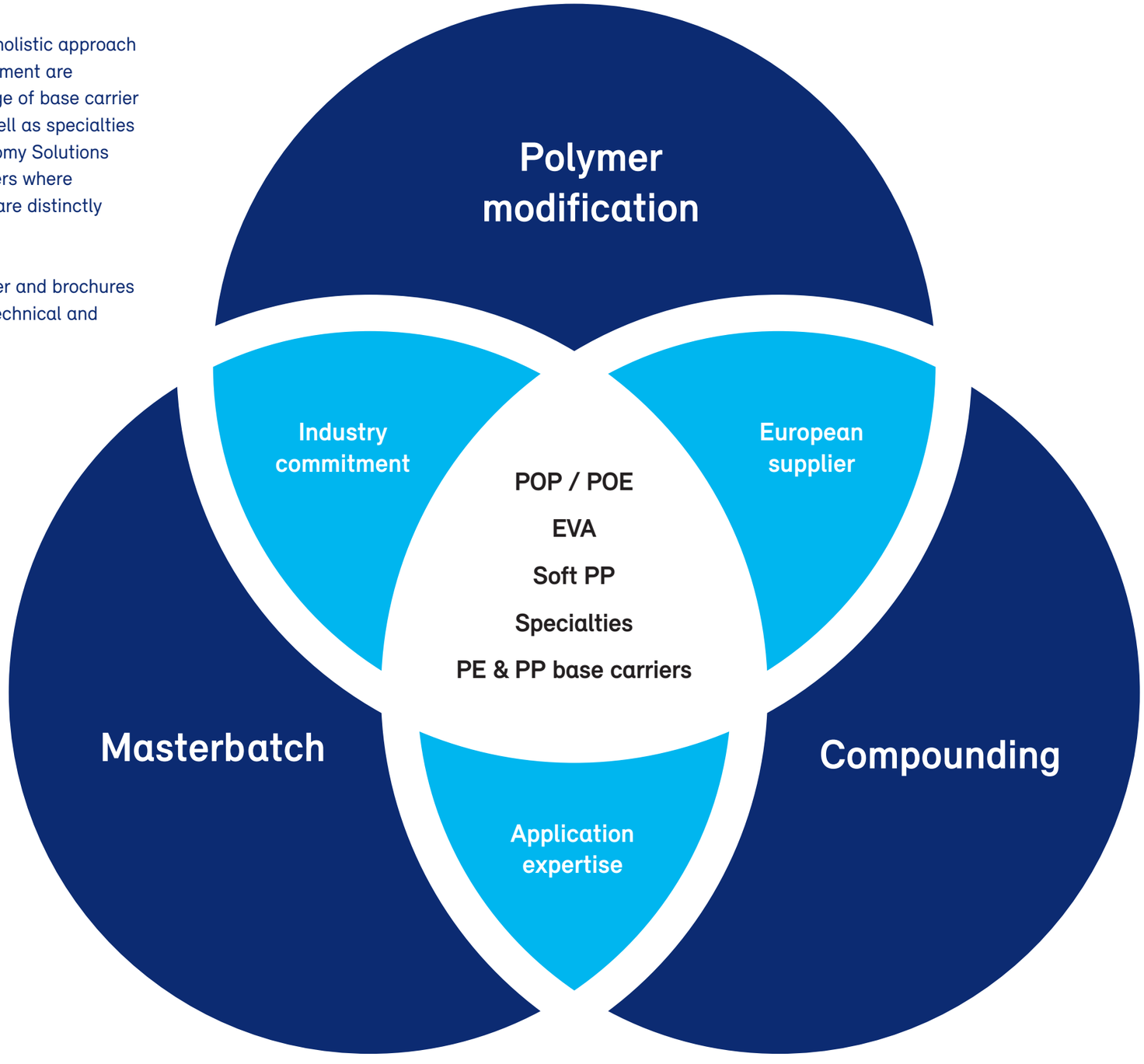
*AO: Anti-Oxidant, CR: Controlled Rheology

Borealis’ supply to the compounding market

Offer

Borealis offers the Compounding, Masterbatch and Polymer Modification market a holistic approach in which application expertise, leading products and commitment to this market segment are combined with local supply, short lead times and technical support for our wide range of base carrier resins (PP; homo-PP, random-PP and block-PP, PE; HDPE, LDPE and LLDPE) as well as specialties such as; Queo POP & POE, EVA, soft heterophasic PPs and Borealis’ Circular Economy Solutions offering in all of these. The Borealis approach allows optimal service to our customers where Masterbatch, Compounding and Polymer Modification overlap, but also were these are distinctly different and benefit from dedicated attention and material offering.

Please visit our website www.borealisgroup.com, where you will find our product offer and brochures under Polyolefins/Polymer Solutions and where you can download a wide array of technical and regulatory statements.



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About Borealis Borealis is one of the world's leading providers of advanced and circular polyolefin solutions and a European market leader in base chemicals, fertilizers and the mechanical recycling of plastics. We leverage our polymers expertise and decades of experience to offer value adding, innovative and circular material solutions for key industries. In re-inventing for more sustainable living, we build on our commitment to safety, our people and excellence as we accelerate the transformation to a circular economy and expand our geographical footprint.

With head offices in Vienna, Austria, Borealis employs 6,900 employees and operates in over 120 countries. In 2021, Borealis generated total sales and other income of EUR 10,153 million and a net profit of EUR 1,396 million. OMV, the Austria-based international oil and gas company, owns 75% of Borealis, while the remaining 25% is owned by a holding company of the Abu-Dhabi based Mubadala. We supply services and products to customers around the globe through Borealis and two important joint ventures: Borouge (with the Abu Dhabi National Oil Company, or ADNOC, based in UAE); and Baystar™ (with TotalEnergies, based in the US).

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