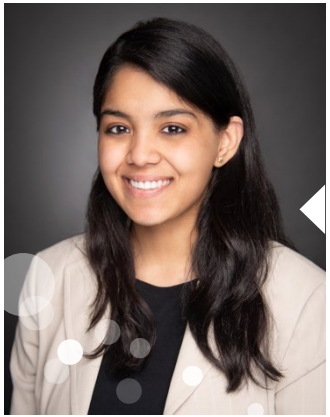
SOLVAY

Progress beyond

Ultrapolymers for High Performance needs in Food Contact Applications

Part II: Ultrapolymers in Food Contact Applications
Ketaspire® PEEK / Avaspire® PAEK / Ketaspire® PEEK XT

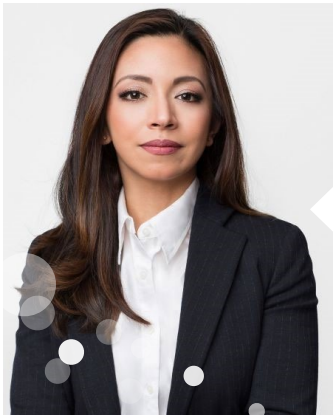
Meet the presenters



Gayatri Anand

Technical Development Engineer
Healthcare and Consumer & Construction
Solvay Specialty Polymers

Gayatri Anand is currently a Technical Development Engineer for Consumer & Construction and Healthcare in North America for Solvay Specialty Polymers based in Alpharetta, Georgia. Gayatri has a B.S. in Polymer Engineering and M.S. in Plastics Engineering from University of Massachusetts. She joined Solvay in 2018 and supports application development, material science and customer support for high-growth market segments.



Judith Bernabé

Sales Development Manager
Consumer & Construction
Solvay Specialty Polymers

Judith Bernabé is currently the Sales Development Manager for Consumer & Construction in North America for Solvay Specialty Polymers in Alpharetta, Georgia. Judith joined Solvay in 2016 and brings 15 years experience in Technical, Sales & Marketing for the chemical industry. She holds a Bachelors of Science in Chemistry from De La Salle University. Her responsibilities include customer development and driving business growth by establishing relevant partnerships in the North American Consumer & Construction Market.

Agenda

- Overview of ultra performance polymers in Consumer Goods – Properties & comparative performance
- UPM applications case studies
- Thermal and mechanical properties
- Regulatory compliance
- Chemical resistance
- Surface properties
- Design and processing
- Conclusion and Q&A

Material selection criteria in consumer Food Contact Applications

Material selection criteria

- Regulatory approvals (Incl. CFDA / FDA / EFSA) -
  First in market for global food compliance with lubricated grades
- Mechanical strength and stiffness
- Thermal stability
- Toughness and impact resistance
- Resistance to chemical aggression (Dishwasher safe)
- Sterilization compatibility (Steam / boiling water)
- Design & processing
- Surface and opticals

Meeting the challenges in consumer Food Contact Applications

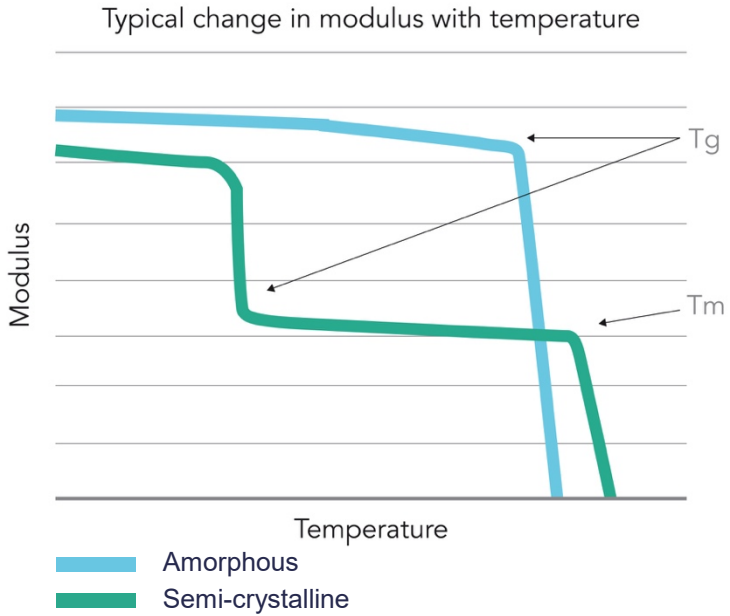
PRODUCT PERFORMANCE
DESIGN / DURABILITY

FOOD CONTACT REGULATIONS
CALIFORNIA PROP 65, EFSA, CFDA, FDA

TOTAL OVERALL COST
MATERIAL, DESIGN OPTIMIZATION, LIFECYCLE COST

Thermal performance of Amorphous (transparent) vs. Crystalline (non-transparent) polymers

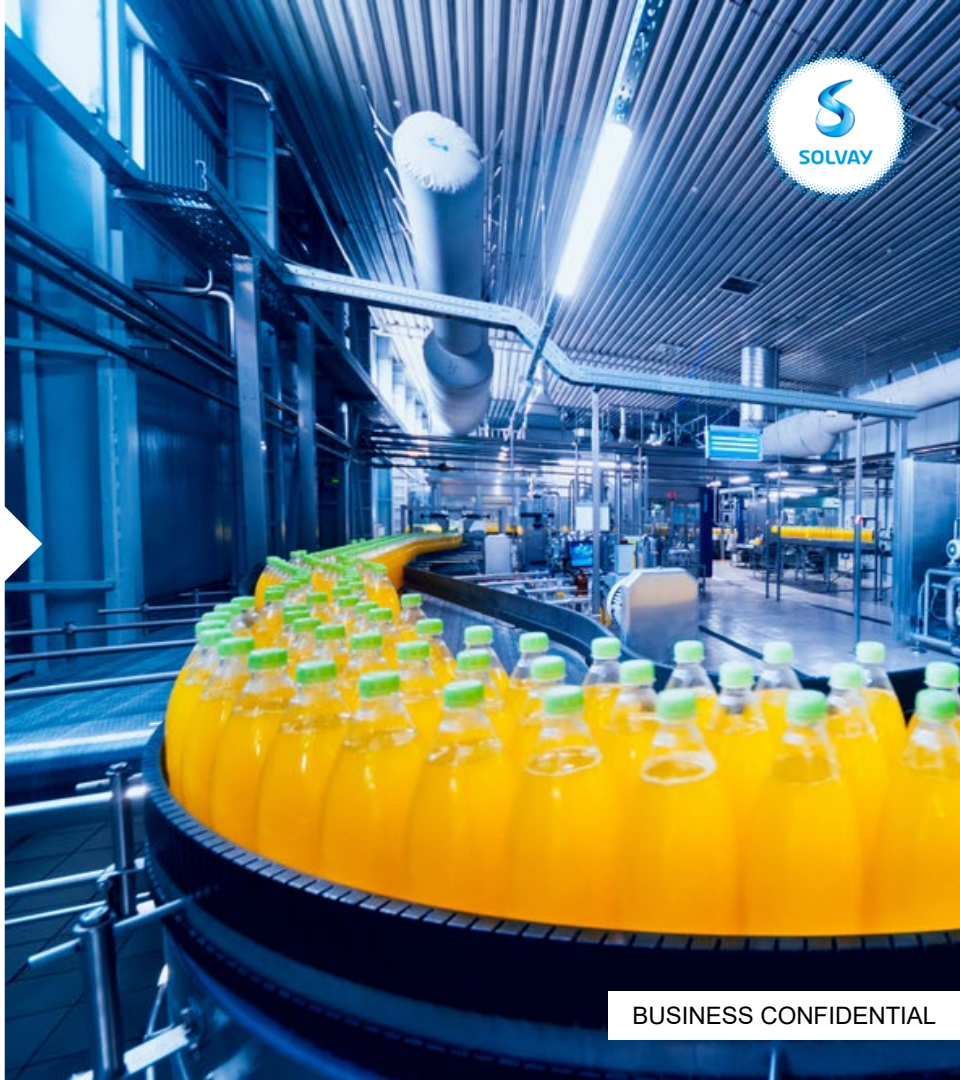
Typical change in modulus with temperature



High performance polymers (HPPs) in Food Contact Space

Typical applications

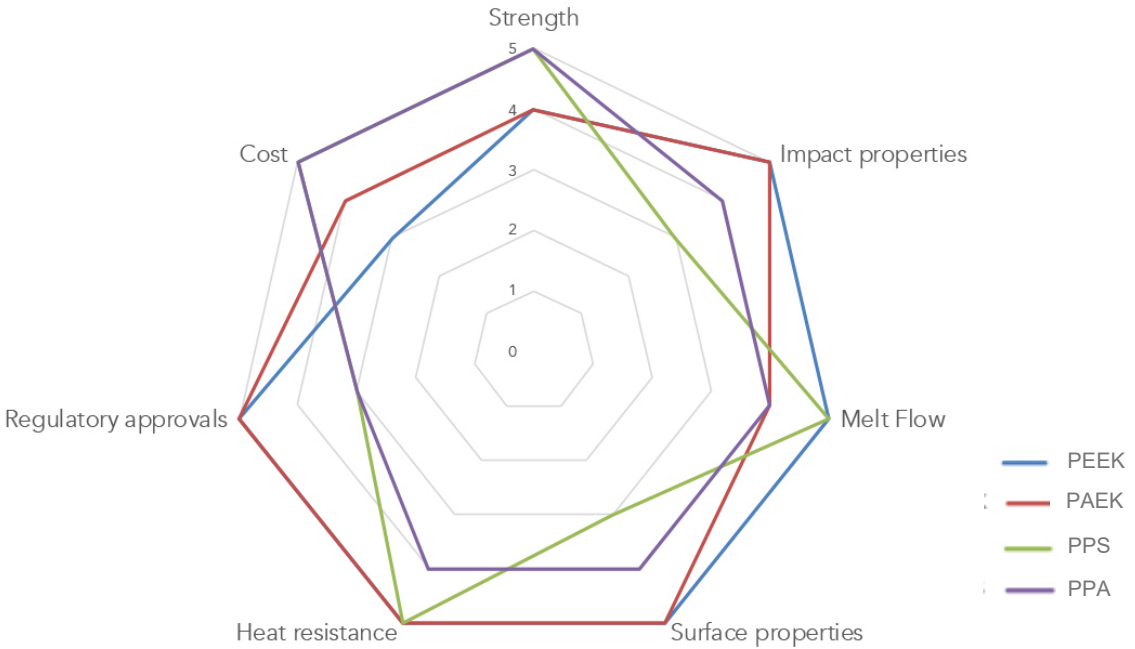
	Food processing & HT Coatings	Commercial beverage appliances	Kitchen appliances (Rice cookers)	Small personal devices
Ketaspire® PEEK	√	√	√	√
Avaspire® PAEK	√	√		√
Ryton® PPS		√		√
Amodel® PPA / Specialty PA		√		√
Torlon® PAI	√		√	
Sulfones	√	√	√	√



Properties and comparative cost overview for high performance materials

Selection decision factors for semi-crystalline polymers in Food-contact

- Surface properties
- Heat resistance
- Regulatory
- Cost
- Mechanical
- Processing - extrusion/molding/additive manufacturing



Ketaspire® PEEK and PEEK XT new family of high temperature PEEK Vs other Polyetherketone products

	Ketaspire® PEEK	Ketaspire® PEEK XT	PEK	PEKEKK	PEKK
Glass Transistion Temp, °C	150	170	160	170	160-165
Melting Point, °C	340	385	373	387	360
Chemical Resistance	4	4	2	3	2
Ether to Ketone Ratio	2:1	2:1	1:1	2:3	1:2
Electrical Properties, 250°C	3	5	Not tested	Not tested	Not tested
Processability	5	5*	3	2	4

*Same as PEEK at 20°C higher

KetaSpire® PEEK XT was introduced to market in 2019 and delivers the best overall performance among the family of Polyetherketone polymers.

World-class Ketaspire® PEEK assets differentiated with best-in-class quality

- Benchmark quality for Solvay Ketaspire® PEEK (black-specs and metal contamination)
- Broad range of thermal and mechanical performance
- Global regulatory compliance
- Broadest portfolio to align with customer cost expectations
- Customers proximity - Global with 2 world-class product assets

Case Study 1:
Food processing applications

- Application:
  Peristaltic pumps, dosing pumps and fittings, high temperature coatings for ultra high temperature applications and filling lines
- Material:
  Ketaspire® KT820NT / Ketaspire® KT880NT / Ketaspire® KT XT-920NT
- Processing method:
  Stock shapes machining / Injection molding / Coating
- Main Value Proposition:
  - Global Regulatory compliance
  - Resistance to food particles (oil / fat)
  - Resistance to disinfectants
  - Continuous Use temperature (>150 °C)
  - Cleanability/ Surface properties
  - Steam resistance
  - Abrasion resistance
  - Mechanical properties

Solvay's portfolio of differentiated Ultrapolymer materials that adhere to Global Food Contact requirements

		Compliance to Food contact
Ketaspire® PEEK	Solvay's Ketaspire® PEEK grades such as KT820NT / KT880NT are the first commercially available grades in the industry to be compliant with US FDA / EU Food contact and China Food contact regulations	
Ketaspire® PEEK XT	Innovative very high temperature PEEK that is commercialized only by Solvay for applications with temperature needs higher than standard PEEK	
Ketaspire® Coatings	A broad portfolio of food contact compliant coating grades with processing and cost advantage over other polymers and competition	
Avaspire® PAEK	Innovative PAEK technology available only from Solvay which bridges the gap in price / performance between PEEK and other high performance material	

Avaspire® PAEK – An Innovative polymer to bridge the price-performance gap to PEEK

	AV-481 BG 15	KT-880 NT	AV-651 BG 15
Tensile Strength (psi)	97	103	87
Tensile Modulus (Ksi)	3.4	3.7	3.0
Tensile Yield Elongation (%)	6.0	5.7	6.2
Tensile Elongation at Break (%)	20-40	10-20	> 40
Flexural Strength (psi)	141	146	124
Flexural Modulus (Ksi)	3.4	3.7	3.1
Notched Izod Impact (ft-lb/in)	1.0	1.0	1.3
Unnotched Izod (ft-lb/in)	No Break	No Break	No Break
HDT at 264 psi/1.8 MPa (°C)	210	160	190
Melt Visc. at 1000 1/s & 400C	170	150	290
Specific Gravity	1.33	1.30	1.30

Key reasons to choose Avaspire® PAEK in Food Contact applications

- Low-cost PEEK alternative
- Higher ductility than PEEK and PPS
- Equivalent or better chemical resistance than PEEK
- Higher thermal capabilities than PPS and PPA
- Lower moisture absorption than PPA
- Low friction and excellent wear resistance in dry and lubricated environments

Case Study 2:
Commercial beverage appliances

- Application:
  Solenoid valves for beverage dispensing (impact resistance & food contact), flow nozzles for high pressure coffee in commercial machines
- Material:
  Ketaspire® KT820NT / Ketaspire® KT880NT / Avaspire® AV 651NT
- Processing method:
  Injection molding
- Main Value Proposition:
  - Regulatory compliance
  - Resistance to food
  - Disinfectants resistance
  - Use temperature
  - Cleanability/ Surface properties
  - Steam resistance
  - Abrasion resistance
  - Mechanical properties

Case Study 3:
Small appliances coffee punch needles

- Application:
  Single and multi punch needles in coffee machine
- Material:
  Ketaspire® KT820NT / Ketaspire® KT880NT / Avaspire® AV 651NT
- Processing method:
  Injection molding
- Main Value Proposition:
  - Regulatory compliance
  - Resistance to food
  - Chemical and high temp resistance
  - Mechanical strength to replace Al/metal
  - Steam resistance
  - Dimension stable
  - Surface hardness
  - Low tendency to calcify
  - Disinfectants resistance

Solvay's Food Contact Approved Coatings Portfolio & Value Proposition

Attributes	Veradel® PESU	Ryton® PPS	Torlon® PAI	Ceramic	Algoflon® PTFE	Ketaspire® PEEK
Maximum Continuous Service Temperature	180 - 200 °C	220 °C	240 °C	250 °C	240 - 260 °C	240 - 260 °C
Abrasion Resistance	+++	+++++	+++++	+	+	+++++
Water Contact Angle	70°	80°	76°	90 → 70°	110°	71°
Coating Smoothness	++++	+++	+++	+++++	+++++	+++++
Resistance to Hydrolysis	+++++	+++++	+++	+++++	+++++	+++++
Supply chain	Formulator	Formulator	Formulator		Formulator	Direct/Formulator

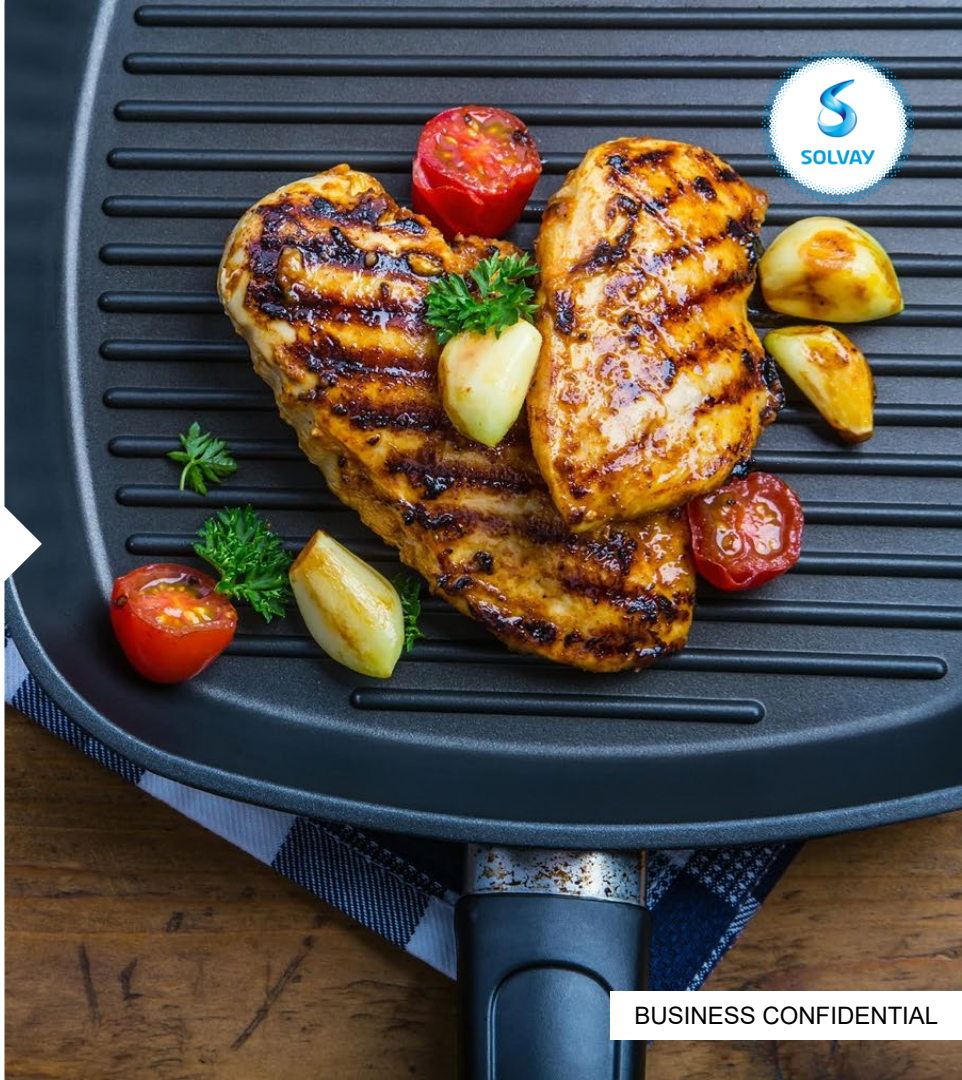
+ low / +++++ high

Case Study 4:
Kitchen appliance coatings

- Application:
  Cooking / baking / grill appliances
- Material:
  Ketaspire® KT820 / Ketaspire® KT880 (P / SFP / UFP grades)
- Processing method:
  Coating
- Main Value Proposition:
  - Food contact approvals
  - High temperature resistance
  - Scratch and abrasion resistance
  - Resistance to dishwashing chemicals
  - Easier processability
  - Surface smoothness closer to Fluoropolymers

Summary value proposition of Ketaspire® PEEK and Avaspire® PAEK

- Performance:
  Ketaspire® PEEK and Avaspire® PAEK portfolio an effective drop-in for metal replacement and for existing PEEK applications
- High temperature:
  Industry's first true high temperature Ketaspire® PEEK XT introduced in 2019
- Food contact compliance:
  Ketaspire® PEEK KT820NT is the first extrusion grade PEEK in market to have China food compliance in addition to US FDA and EU Food
- Portfolio:
  Extremely broad portfolio with Natural, carbon-fiber, glass-fiber filled grades for multiple applications
- Cleanliness:
  Ketaspire® PEEK exhibits superior cleanliness and less defects, black specs and gels vs competition

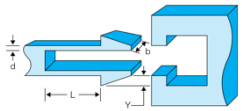


How do PEEK / PAEK polymers compare to other polymers on cost front?

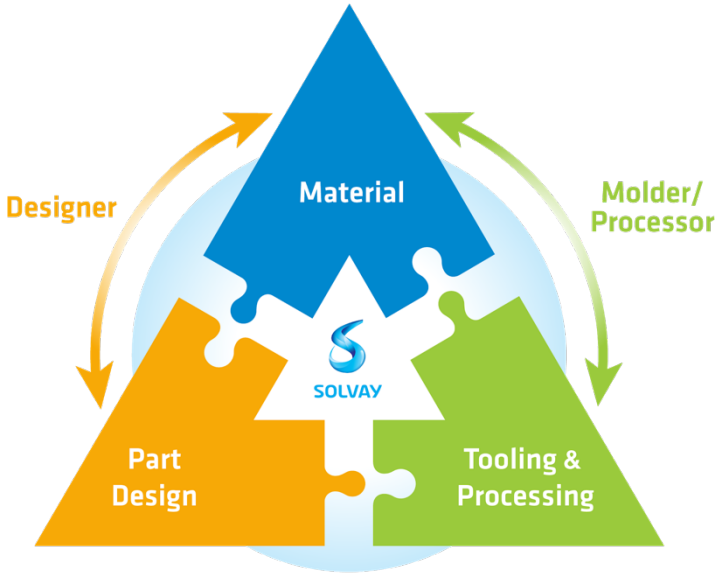
In selecting polymers always consider the total lifecycle cost which is impacted by following factors:

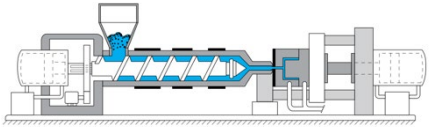
- Material cost: Price/Kg, Density
- Processing costs: Melt & Mold temperatures
- Design: Thinner walled parts / functional integration
- Capex: Mold / Tool investment Vs operating life (Eg: 100k parts / tool for metal Vs 1Mn parts / tool for polymers)
- Post processing: Curing, Annealing
- Replacement / Maintenance frequency: Number of times the part needs to be replaced or serviced

Collaboration holds the key to design the most effective part and select the best material for an application



Performance
Geometry
Lifecycle
Regulations
Cost
Etc.



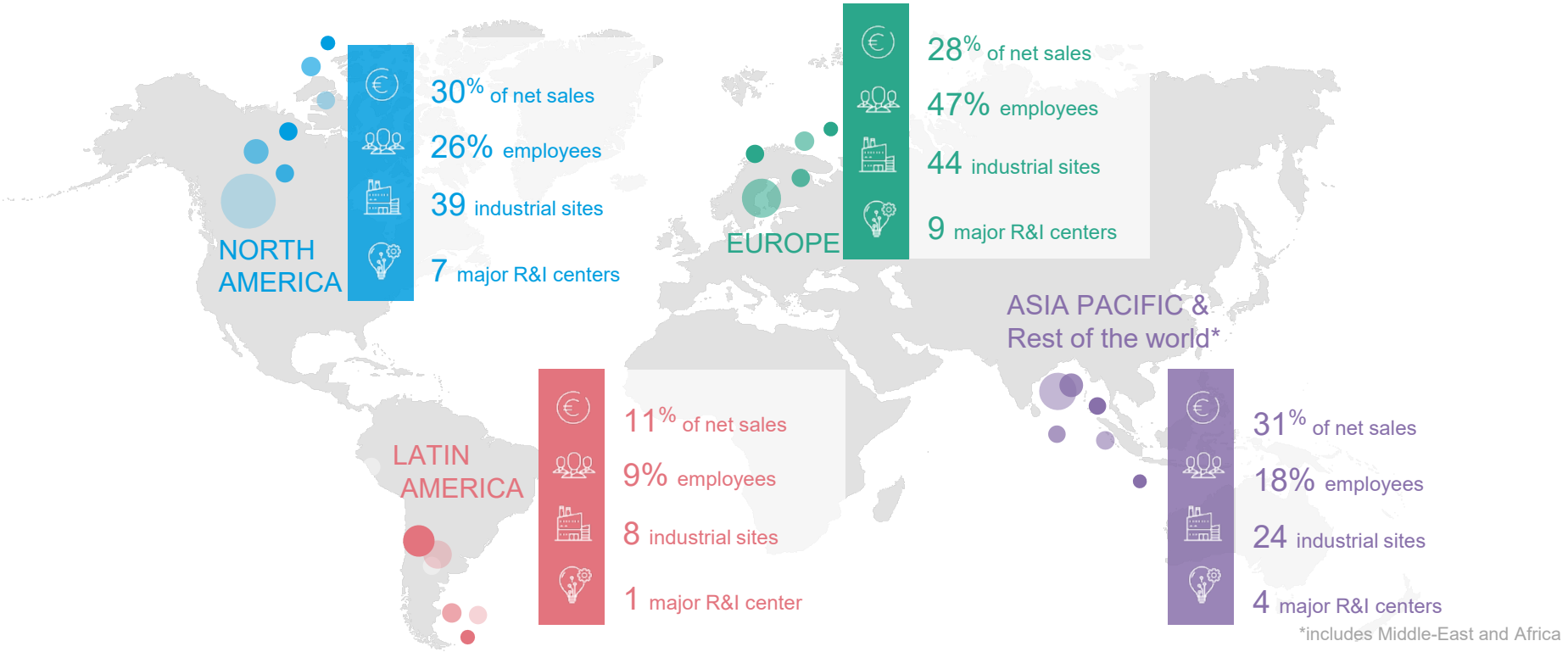


Processing
Tooling
Moldability
Cycle time
Yield, margin
Etc.

Leverage the Solvay CAE and mold support capabilities to arrive at the best possible design enabling cost optimization, compliance and performance enhancement.

A balanced presence worldwide

2019 figures



2019 key figures

24,100
Employees

64
Countries

115
Industrial sites

We are an advanced materials and specialty chemicals company, committed to address key societal challenges

€10.2 billion
Underlying net sales

€2.3 billion
Underlying EBITDA

53%
Net sales generated by sustainable solutions

21
Major R&I centers

-5%
Greenhouse gas intensity

TOP 3
Market position in ~ 90% of portfolio

Figures take in account the divestment of the polyamide business completed on 2020 January 31

Questions?

Progress beyond

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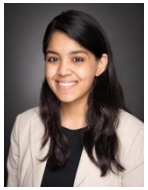

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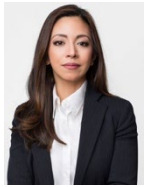

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