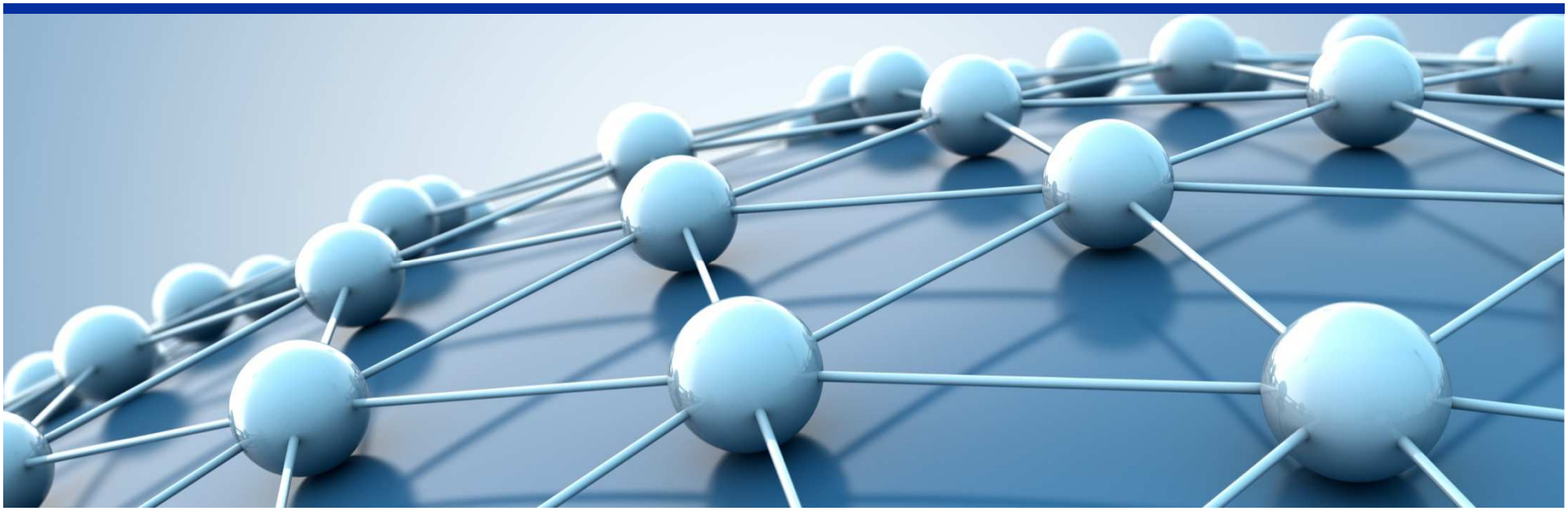


Ravago Petrokimya
Sustainable Material Solutions

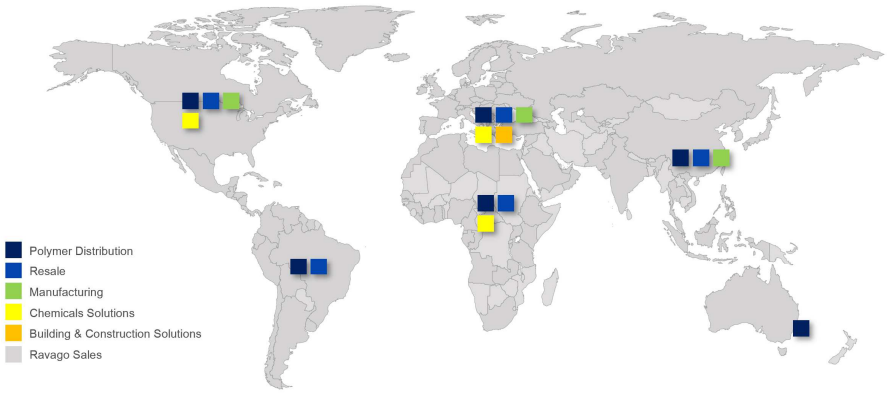
PAGEV Meeting 4.12.2018 Ümit Makal Yakup Ülçer

Facts & figures

Ravago Group

Revenue: 8.7 bln EUR

Volume: 5.8 mln MT



Leading plastic and rubber polymer distributor

6,000+	45,000+	230+	1,500+	20,000+
employees	customers worldwide	locations worldwide	suppliers	product references
More than 30% are dedicated local sales employees	Large loyal customer base	Across 57 countries	Of which 50 strategic supplier partnerships	Large portfolio

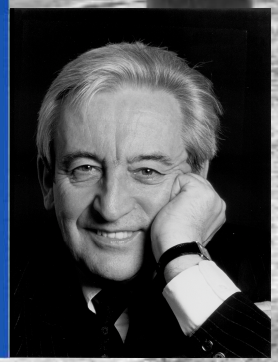
Ravago Group

History

When Raf Van Gorp founded Ravago in 1961, he was given the opportunity to buy the premises of a dynamite company in Arendonk, Belgium. This enabled him to work out the luminous idea he had: recycling production waste from the plastics producing petrochemical companies.

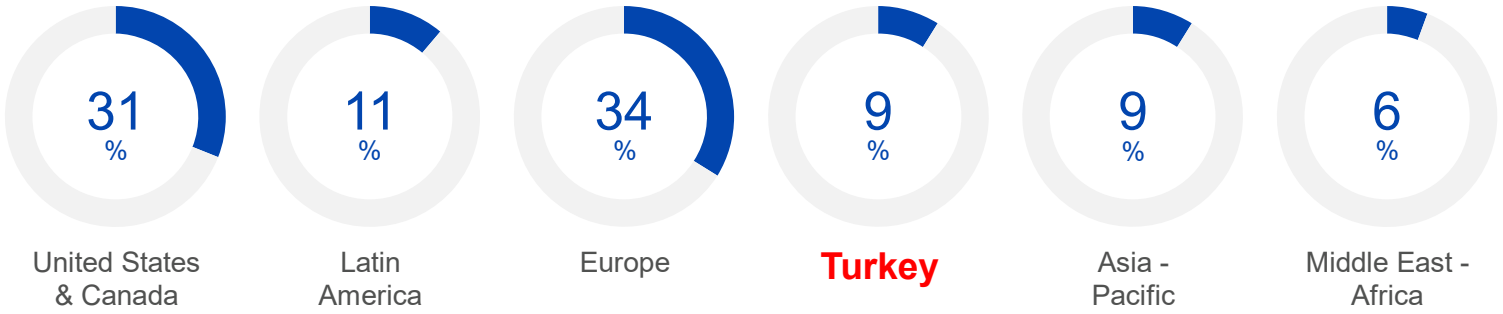
From there, the company grew into a successful service provider to the petrochemical industry as a distributor and reseller of plastic resins. Production and distribution of building products guaranteed a second revenue line in Europe. Distribution and trading of chemicals is the most recent activity of the Group.

Today, the Ravago Group is the number one service provider in the global market of plastics, rubber and chemicals.



Global Revenue Generation

Ravago Group



Manufacturing and RPK

- Represents 11% of FY 2017 revenue
- 2 business units
  - Recycling & compounding
  - Expandable polystyrene (EPS)
- 24 production plants with ~1 mln MT capacity
  - 11 in Europe
  - 8 in North America
  - 4 in Asia
  - 1 in Africa
- Products
  - Plastics, rubbers, chemicals
- End markets
  - Automotive, electronics, building & construction industry

Ravago PetrokimyaTurkey

	Izmir Aliaga Plant	TAYSAD Plant
Production	TPE EP EPS	Silicones TPU PU Systems R/D Center
Total Area	210.000 m2	20.000 m2
Total Capacity	45.000 MT TPE 25.000 MT EP 150.000 MT EPS	10.000MT TPU 60.000MT PU Systems

Ravago Petrokimya Business Units

Thermoplastic Elastomers (TPE)

Engineering Plastics (EP)

Thermoplastic Polyurethane (TPU)

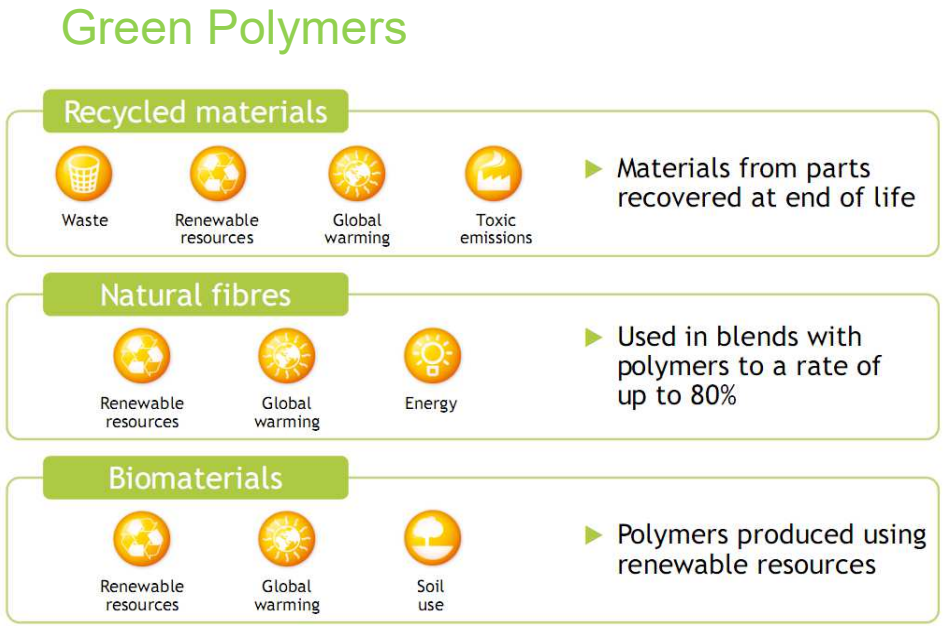
Polyurethane Systems (PU)

Silicone Compunds

Innovative and Hybrid Solutions

What Do Sustainable Solutions Mean to Ravago?

- Recycled Materials(EP and TPE)
  - Post industrial or Post consumer material based compounds.
- Natural Fillers (EP)
  - Natural Fibers
  - Natural Fillers (esp. waste material)
- Bio- Polymers (EP, PU and TPU)
  - Polymers and Compounds with more than 20% renewable material



Engineering Plastics

PP and PA solutions

Recycled Materials: Post industrial waste PP compounds meeting new emission standards

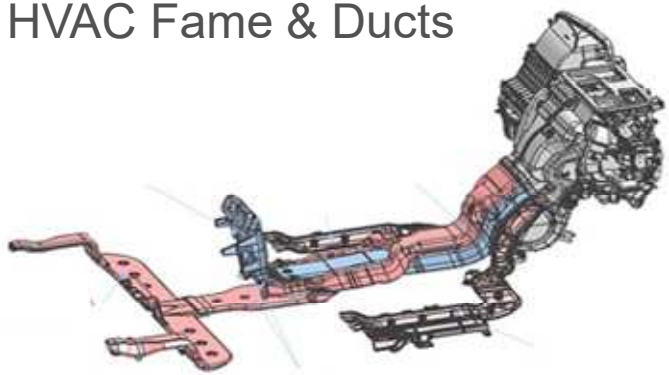
Talcum and Glass Fiber Reinforced Grades for Automotive Interior Applications

- Selected post industrial recycled raw materials,
- Proprietery Quality procedures, to ensure proper traceability, consistence, homogeneity and high-performance characteristics.
- Proprietary formulation and compounding technology meeting new anutomotive interior VOC, Fogging heat and UV stability requirements.

Recycled PP applications

Approved in several major Automotive OEM'S

HVAC Fame & Ducts



Dashboard Structure & Central console

Natural Fillers: Wood Fibers

Ecological and Light Weight PP Compounds to replace Talcum Reinfoced PP

Test	Unit	Standard	PP with 20% Talcum	PP with 40% Talcum	PP with 25% Wood Fiber	PP with 30% Wood Fiber
Density	gr/cm^3	ISO 1183-Method A	1,04	1,15	0,97	1,02
Tensile Strength at Break	MPa	ISO 527-1, 50 mm/min	29	24	30,4	31,5
Tensile Modulus	MPa	ISO 527-1, 1 mm/min	2400	3000	2720	3100
Flexural Modulus	MPa	ISO 178	2200	3200	2460	2990
Impact Strength, Notched Izod at 23 C°	kj/m^2	ISO 179-1	4,3	1,5	5	6
Heat Deflaction Temperature at 1.8 MPa	C°	ISO 75A	66	62	81	91,6

12-15% low weight saving compared to Talcum

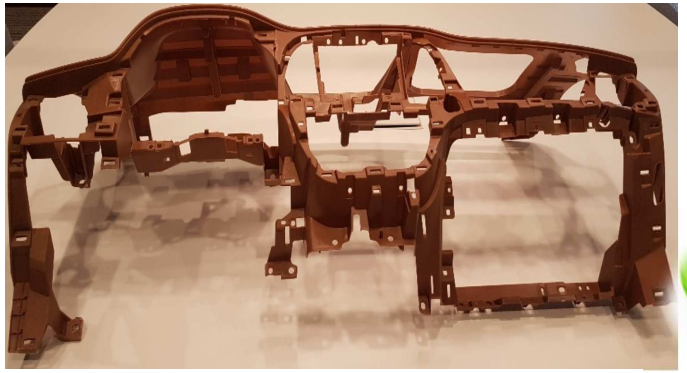
Natural Fillers: Composite Solutions

Wood and Glass Fiber Combination to replace Glass fiber Reinforced PP compouds

Applications of natural fiber composites in vehicles by different manufacturers

Manufacturer	Model	NFC composite parts
Audi	A2, A3, A4, Avant, A6	Seat backs, side and back door panel, boot lining, hat track, and spare tire lining
BMW	3, 5, and 7 series and others	Door panels, headliner panel, noise insulation panels, seat backs, molded foot and well linings
Daimler/Chrysler	A,C, E, and S Class Evo Bus (exterior)	Door panel, windshield, dash board, business table, and pillar cover panel
FORD	Mondeo CD 162, FOCUS	Door panles, B-Pillar, and boot liner
Mercedes-Benz	Trucks	Internal engine cover, engine insulation, sun visor, interior insulation, bumper, wheel box and roof cover
Toyota	Brevis, Harrier, Celsior, RAUM	Door panels, seat backs, and spare tire cover
Volkswagen	Golf, Passat, Variant, Bora, Fox, Polo	Door panels, seat backs, boot liner, and boot lid finish panel
Volvo	C70, V70	Seat padding, natural foams, and cargo floor tray.

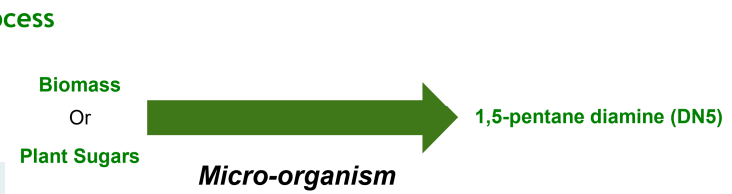
%12 weight reduction

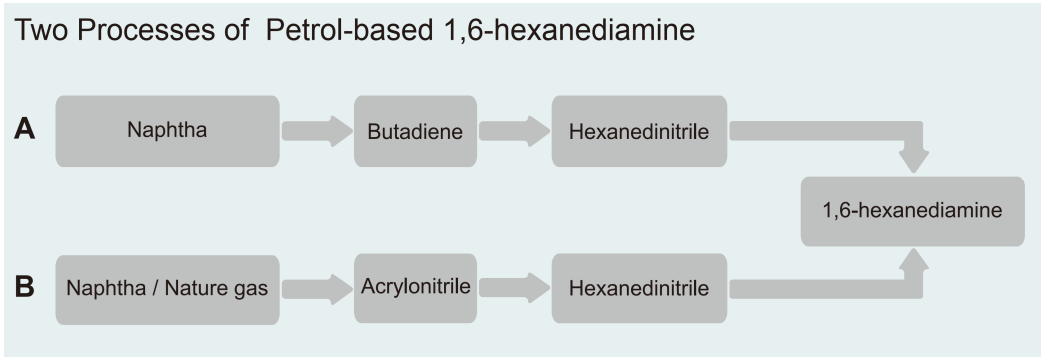


Bio Based Polymers: Polyamide 5.6

Sustainable PA series will be launched in Jan 2019

- New Bio-origin Diamine based Polyamide (40% renewable content)
- Properties intermediate between PA6 and 6.6
- Good processability
- Excellent surface appearance
- 4 times less CO2 generation vs PA6.6





Bio Based Polyamide 5.6

30% GF Content		PA66	PA6	PA56
Tests	Unit			
Density	gr / cm3	1,36	1,36	1,36
Tensile Strength at Break	MPa	180	167	184
Elongation at Break	%	2,99	3,6	3,7
Tensile Modulus	MPa	9970	9560	9660
Izod Impact Strength (Notched)	kj/m2	10,5	14	10
HDT (1.8 Mpa)	°C	247,5	207,8	228,6
Charpy Impact Strength (Notched)	kj/m2	12,5	14	11,5
Flextural Modulus	Mpa	7890	7220	7670
Flextural Strength	Mpa	261	236	267
Vicat Softening Point (50C/50N)	°C	251,9	211,1	236,7
Ash	%	30	30,1	30

Bio-based Polyamide 56

50% GF Content		PA66	PA6	PA56
Tests	Unit			
Density	gr / cm3	1,57	1,57	1,57
Tensile Strength at Break	MPa	243	214	248
Elongation at Break	%	2,5	3,3	2,8
Tensile Modulus	MPa	15200	14500	15000
Izod Impact Strength (Notched)	kj/m2	13	19	14
HDT (1.8 Mpa)	°C	248,6	218,9	233,6
Charpy Impact Strength (Notched)	kj/m2	16,5	18	16,8
Flextural Modulus	Mpa	14800	13720	14200
Flextural Strength	Mpa	352	335	351
Vicat Softening Point (50C/50N)	°C	253,3	214	237,8
Ash	%	49,5	50,1	50

TPE and TPU Solutions

Bio Origin and Recycled TPE Solutions

New Series will be launched in K fair.

Bio Origin Materials

- TPV's Up to 60% Bio origin
- Styrenic TPE's Up to 40% Bio origin
- Up to 40% Bio origin TPU grades

Recyled Materials

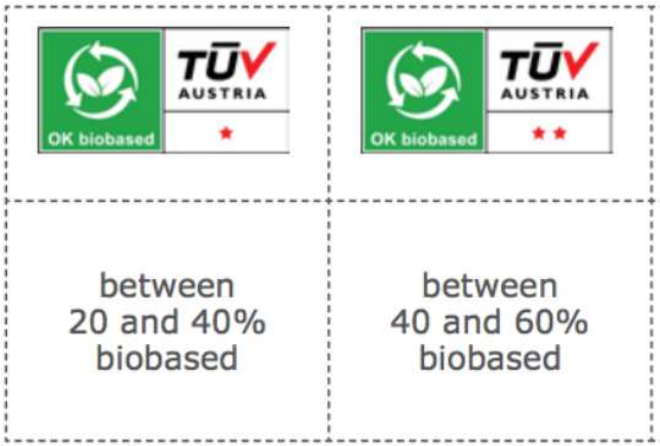
- Post industrial recycled TPV grades
- Post industrial recycled SEBS grades

PU Solutions

New Ravago PU Systems

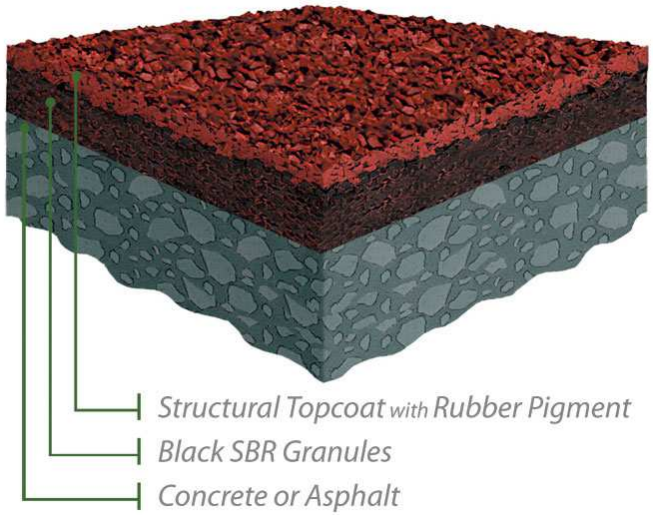
Ravago PU systems from renewable resources

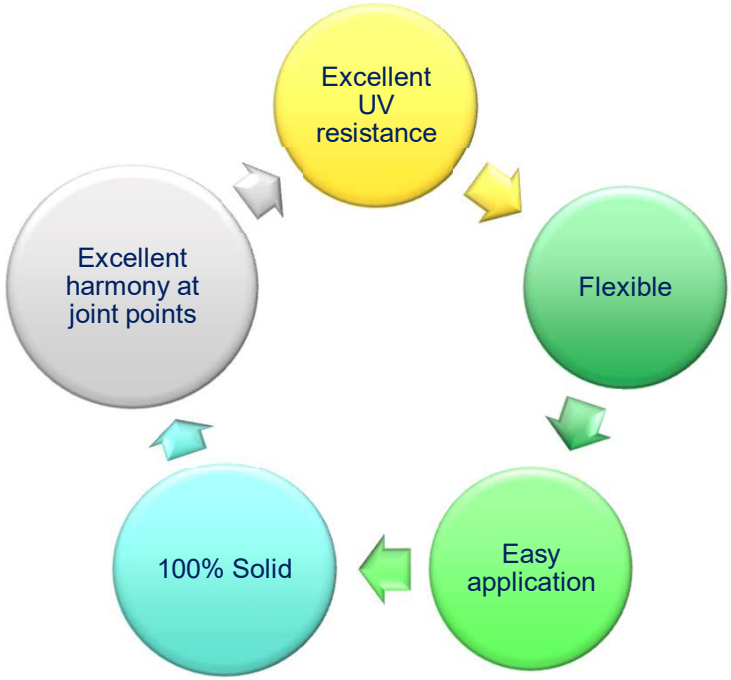
- Market trend to reinfoce using/increasing biobased materials.
- New polyol systems up to 60% renewable content
- New foams up to 25% renewable content.
- Automotive and industrial applications.



New Ravago PU Systems

Ravago non-yellowing binders for Recycled SBR





Color Change After UV Light

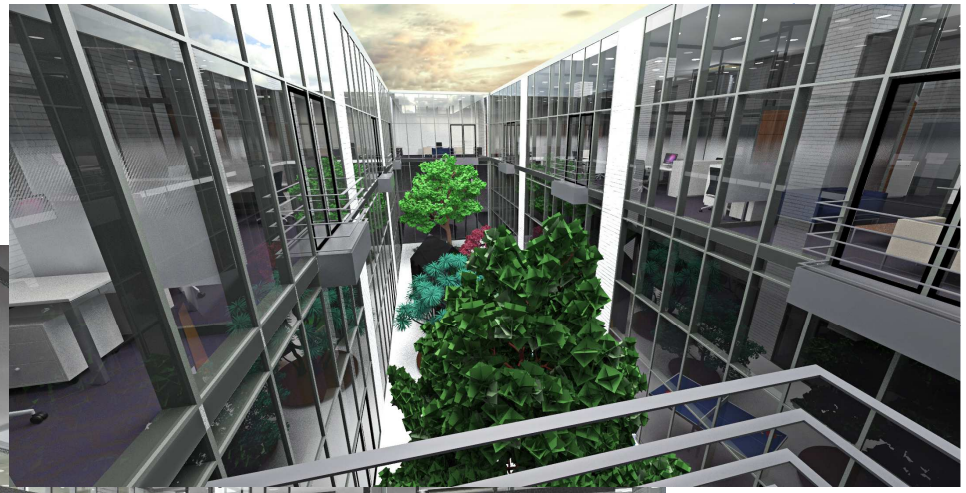
AROMATIC BINDER

ALIPHATIC BINDER

RAVAGO Petrokimya Üretim A.Ş.
Research and Development Center

Ravago R&D center

3500 m2 research complex



RD Center TPE –EP Laboratories

- Technology Laboratory
- Mechanical Laboratory
- Flammability Laboratory
- Rheology Laboratory
- UV Ageing Laboratory
- Ageing Laboratory
- Chemical Laboratory
- Pilot Production Center

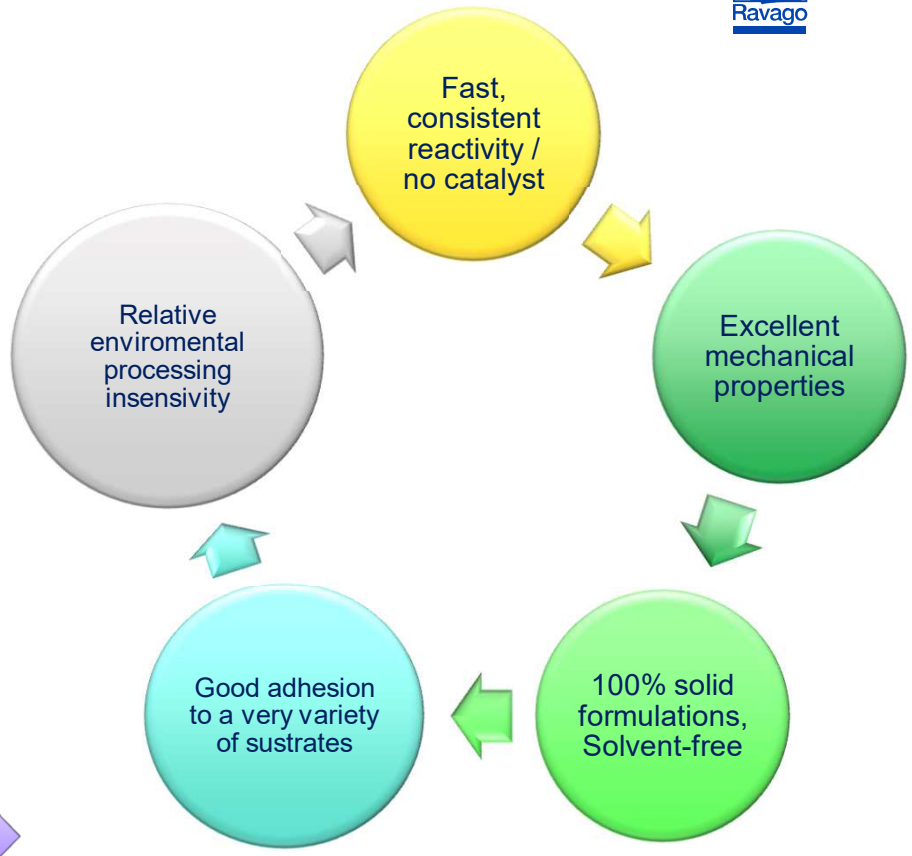
RD Center – Pilot Scale Production Equipments

- Injection Machine for EP (Engel Victory 50)
- Co-Injection Machine for EP/TPE (Engel Victory 90/50)
- Blow Molding Machine
- Thermo Haake system Blending Extrusion Equipment
- Pre-mixing Equipment
- TPU Calendering Extruder
- Silicone Rubber Two Roll Mill
- Silicon Rubber Internal Mixer
- TPE Twin Screw Extruder
- EP Twin Screw Extruder
- Cannon PU foaming Machine
- Pilot Reactor
- Spray Coating

Polyurea Characteristic

PURE POLYUREA

HYBRID POLYUREA



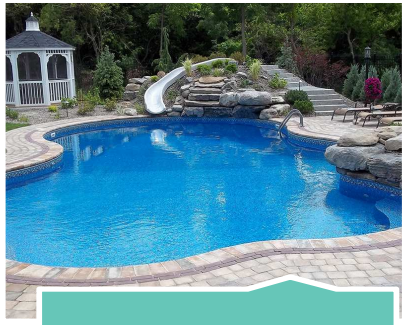
Polyurea Test Results & Application Fields

- Pot Life: 3-5 sec
- Tack free time: 10-15 sec
- Tensile strength: 25±3 MPa
- Hardness: 44±5 Shore D
- Elongation: 400±25 %
- Tear Strength: 110±15 N/mm
- Pull off adhesion test: 4,4 N/mm²

Construction

Truck Bed Liner

Car Parks

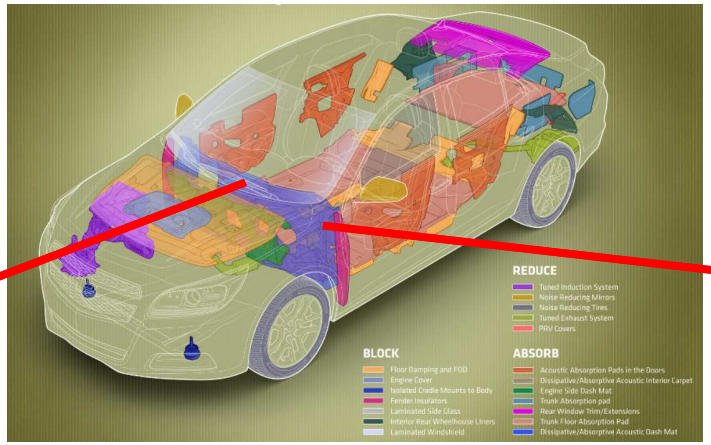


Pools

Polyurea

New Ravago PU Systems

New Ravago PU systems for acoustic insulation for automotive



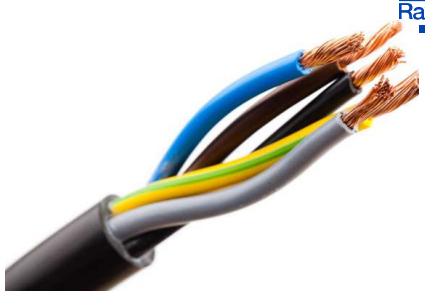
New Ravago PU Systems

New Ravago FR Flexible Molded PU systems

ECE R
118.2
ANNEX
6,7,8

BS 5852
PART2
(CRIB 5)

New Ravago HFFR-TPU Systems



- General purpose insulation and sheathing applications – EN 50363-10-2 standard.
- Low smoke, excellent processing, and mechanical properties.
- Halogen free FR Polyether TPUs grades.
- Excellent flame retardancy.
- Excellent hydrolysis resistance.
- Low temperature flexibility.
- Micro-organism resistance.

RAVASAFE ZH - TPU	TPU 1	TPU 2	TPU 3
APPLICATION	INSULATION JACKETING	JACKETING	JACKETING
Density@ 23° C (g/cm³)	1.24	1.23	1.25
Tensile Strength (MPa)	>25	>30	>25
Elongation at Break (%)	>500	>500	>500
Oxygen Index **	**24**	24	24
UL 94 Flame Rate	**V-2**	**V-0**	**V-0**
Flame test on cable	**IEC 60332-1**	**IEC 60332-1**	**IEC 60332-1 UL 1581 FT1**

Other innovative studies

Ongoing projects of the R/D Center.

- Thermally and Electrically conductive compounds
- Foamed TPE’s to replace foamed EPDM
- New generation Anti microbial Compounds and MB.
- Ravatech Hybrid TPE solutions that extend the applications of TPU and COPE

Thank you

For more information about Ravago,
please visit our website **www.ravago.com**