Reactor grades from *Catalloy* technology for Wire & Cables

Outstanding properties to help customers' innovative solutions

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Agenda

- Introduction to *Catalloy* technology
- Benefits of the *Catalloy* technology
- Grades from *Catalloy* technology: Wire & Cable Building Blocks in Low Smoke-Halogen Free- Flame Retardant (LS-HF FR) compounds
- Grades from *Catalloy* technology in X-Linking
- Summary table of grades from *Catalloy* technology for cable applications
- Disclaimer

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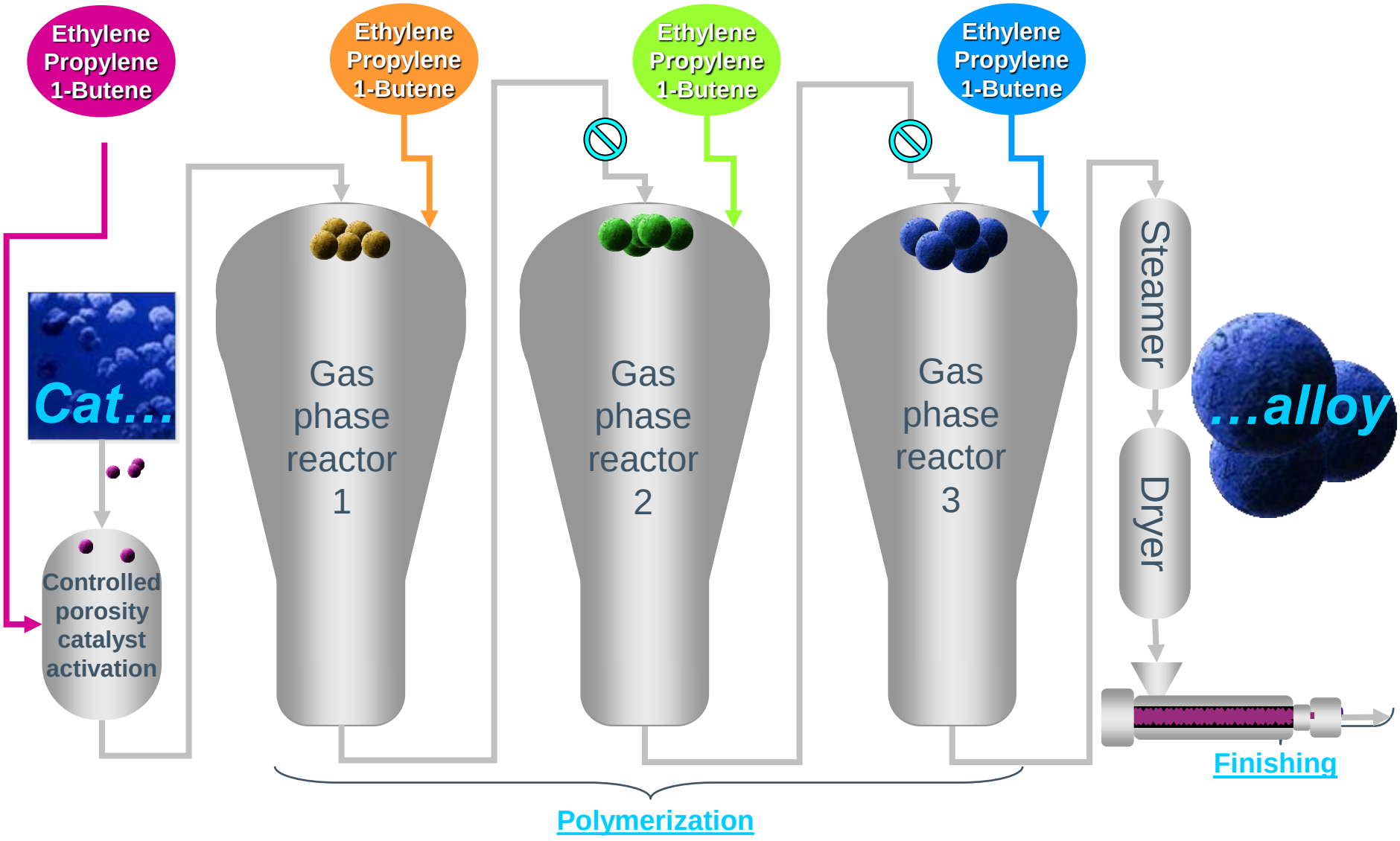
Catalloy Polymerization Technology



Catalloy Production Assets

- **Europe**
  - Italy – Ferrara
  - Netherlands – Moerdijk
  - Italy – Ferrara (Pilot plant)


Moerdijk (NL)

- **North America**
  - USA – Bayport
  - USA – Lake Charles


Lake Charles (NA)

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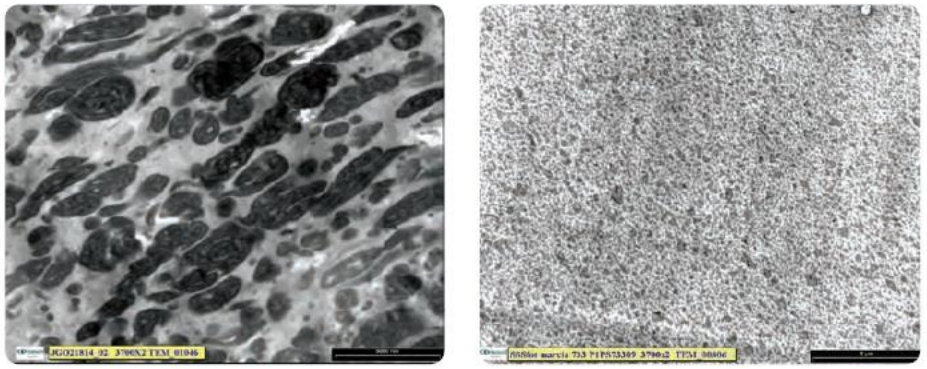
Benefits of the *Catalloy* technology – Physical Property Performance

- ***Catalloy* technology creates a PP/EPR (Ethylene Propylene Rubber) alloy directly in the polymerization reactors**
- **This results in a very fine and uniform rubber dispersion that allows for optimum:**
  - Impact/Stiffness Balance
  - Thermal Resistance
  - Cold Temperature Impact
  - Creep Resistance
  - Softness
  - Toughness
  - Tear Resistance
  - Puncture Resistance
  - Controlled Shrinkage
  - Good Dimensional Stability

Comparative structure
EPR mechanical blend *vs* grade from *Catalloy* technology

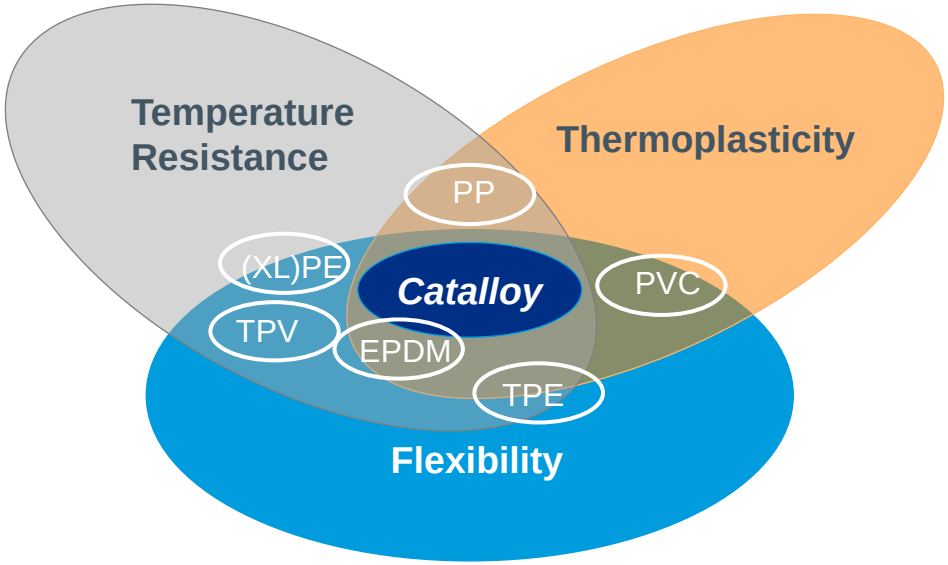
Ethylene Propylene Rubber Blend



TEM (transmission electron microscopy) – 3700X

Grades from *Catalloy* technology: Advancing polypropylene properties profile

- Grades from *Catalloy* technology offer a unique set of properties that can outperform other polymers
- Grades from *Catalloy* technology combine the high thermo-mechanical properties of polypropylene with high flexibility
- The combination of thermoplastic properties, high temperature performance and flexibility makes grades from *Catalloy* technology a good candidate material for Wire and Cable (W&C) applications, or as building blocks in specific W&C compounds, especially Low Smoke-Halogen Free- Flame Retardant



Grades from *Catalloy* technology offer an advanced properties profile for Wire & Cable applications

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Grades from *Catalloy* technology
Wire & Cable Building Blocks in LS-HF FR compounds

Flexibility	Far better than standard polypropylene: ▪ Shore A down to 75 ▪ Flexural Modulus down to 20 MPa
Temperature Resistance	Broad temperature in use-range: ▪ Melting temperature up to 163°C ▪ Ductile/Brittle temperature down to < -50 °C
Thermoplasticity	Easy processing and reprocessability even after crosslinking
Compatibility	Excellent with most of polyolefins, EPDM and styrene-block-copolymers
Filler Loading	Excellent absorption of flame retardants, coupling agents and/or processing aids, maintaining high level of ductility and flexibility

Grades from *Catalloy* technology can offer outstanding performance properties

Grades from *Catalloy* technology: Wire & Cable Building Blocks in LS-HF FR compounds

By selecting appropriate grades from *Catalloy* technology, interesting tensile properties can be achieved for highly filled flame retardant compounds.

Example of Low Smoke-Halogen Free-Flame Retardant formulations

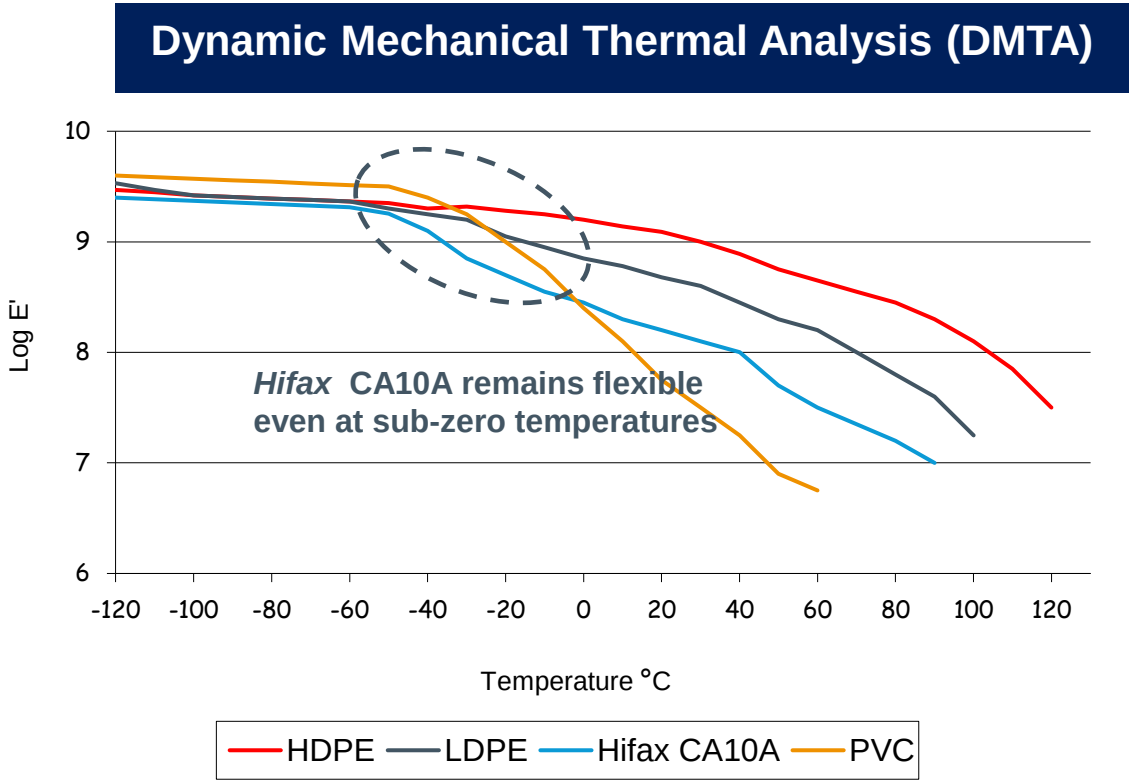
		Case A	Case B	Case C
Hifax CA10A	phr	100	50	-
Softell CA02A	phr	-	50	100
Magnesium Hydroxide	phr	240	240	240
Coupling agent	phr	15	15	15
Processing Aid	phr	2	2	2
Anti Oxidant	phr	2	2	2
Mechanical Properties				
Tensile Strength	MPa	14	11	8
Elongation at Break	%	> 200	> 300	> 400
Shore D	-	45	40	36

***Hifax* and *Softell* reactor grades are used by customers as base raw materials in compounded systems for Low Smoke-Halogen Free- Flame Retardant low voltage cables requiring elevated temperature performance**

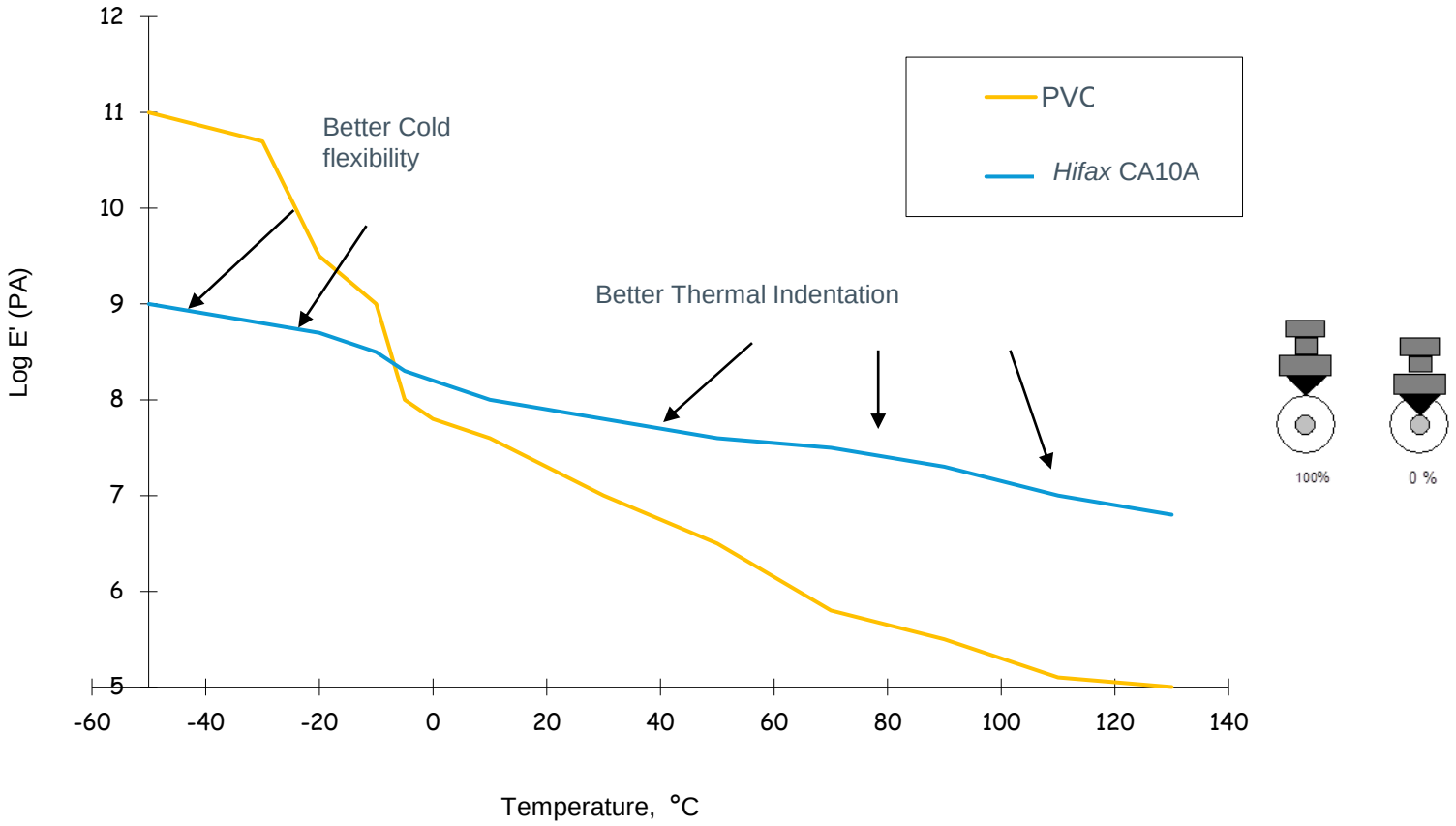
Flexibility and Thermal Performance

Hifax CA10A

- Tensile Modulus: 85 Mpa
- Tensile Strength : 11 Mpa
- Tensile Strain > 500 Mpa
- Hardness shore D: 30
- Melting Temperature 142°C



Flexibility and Thermal Performance



Exceptional balance between softness and thermal performance: ideal candidates for polyolefins-based cable design

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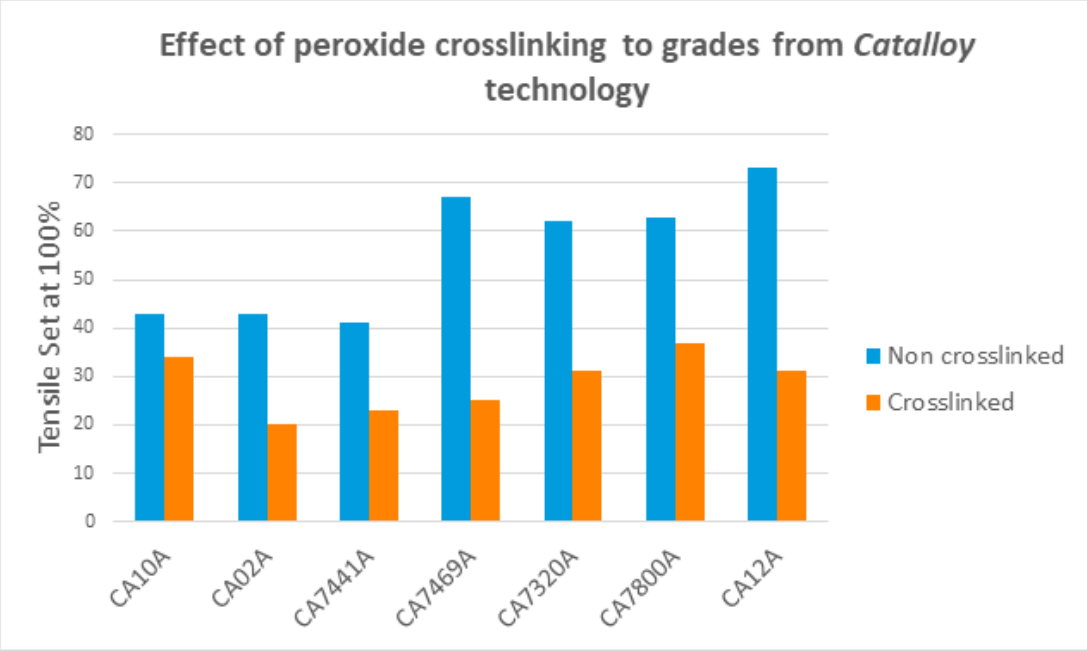
Grades from *Catalloy* technology for crosslinked recipes (building block)

Cross-linking capabilities of grades from *Catalloy* technology

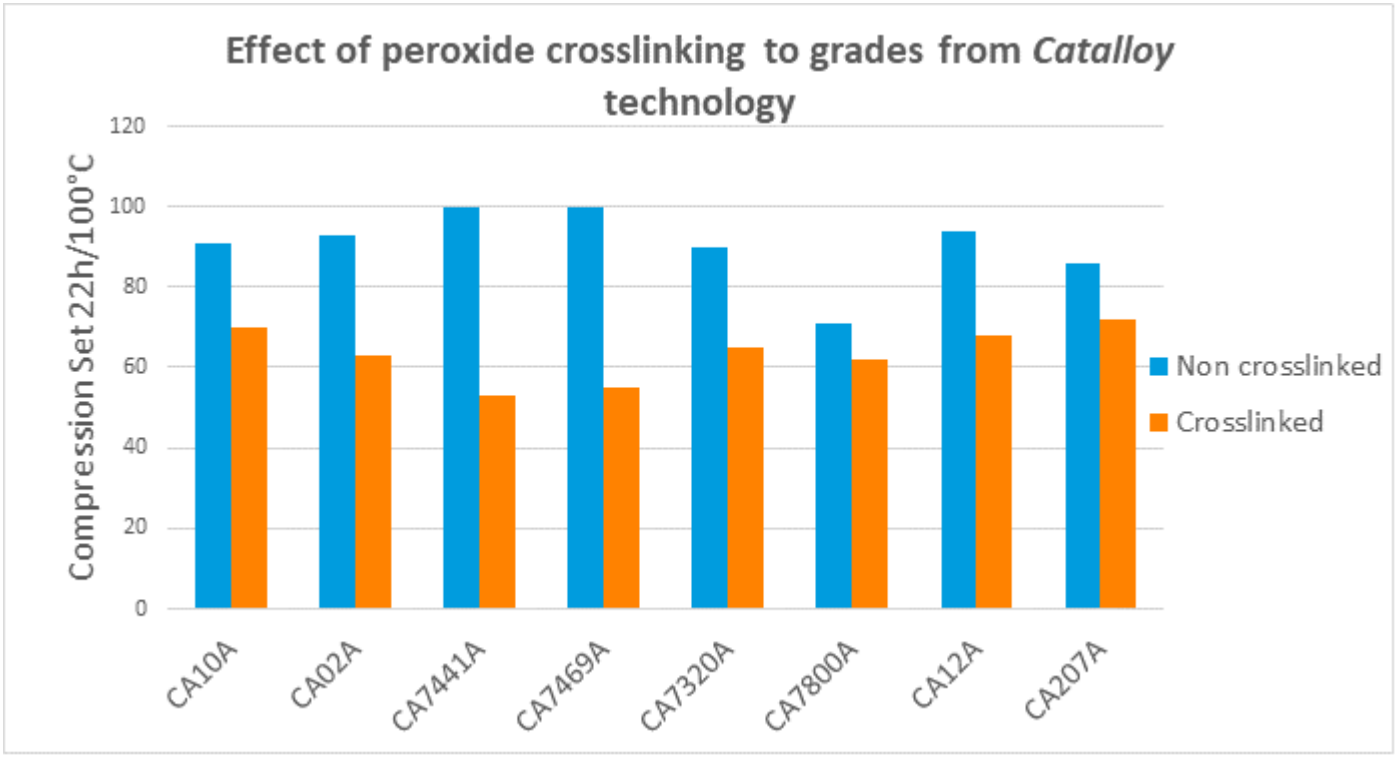
Grades from *Catalloy* technology are used to improve the performance of crosslinked Wire & Cable compounds in terms of flexibility, processability, thermoplasticity.



Lab scale testing

Grades from *Catalloy* technology used as building blocks in cable compounds are reactive to the Organic Peroxide/Coagent, Organosilane / Peroxide (one or two-steps processes), E-beam irradiation.

Grades from *Catalloy* technology for crosslinked recipes (building block)



Lab scale testing

Significant improvement of elastic behavior after crosslinking.
The product remains fully reprocessable.

Hiflex grades key properties

***Hiflex* CA7800A and *Hiflex* CA7700A materials are a new generation of grades from *Catalloy* technology that offer:**

- Easy handling and storage
- Good flexibility
- Good thermal properties at high/low temperatures
- High compatibility with PE
- Good crosslinking behavior
- Good electrical properties

Hiflex	CA7800A	CA7700A
Typical Properties	Value	Value
Density, g/cm^3	0.88	0,88
MFR (230°C/2.16 kg), g/10 min	1,2	1,4
Flexural Modulus, MPa	210	170
Shore D Hardness	35	33
DSC Melting temperature, °C	161	143
Volume Resistivity, Ω cm	6 x 10^{16}	6 x 10^{16}
Dielectric Strength, kV/mm	49	49
Dielectric Constant (1 KHz)	2.3	2,3
Dissipation Factor (1KHz)	0.001	0,0007

These are typical property values not to be construed as specification limits

The new *Hiflex* reactor grades are ideal candidates for cable technical compounds

Hifax CA 7441 A for energy distribution cables

Description

- High flexibility
- Good impact properties at low temperatures
- High melting point
- Good electrical properties
- Good Processing

Typical customer applications

- Low Voltage and Medium Voltage power cable insulations
- Cable jacketing (unfilled)
- Low Smoke-Halogen Free- Flame Retardant (LS-HF FR) compounds
- Cable compounds
- Softener (building block)

Typical Properties	Value
Density, g/cm³	0.88
MFR (230°C/2.16 kg), g/10 min	0.8
Flexural Modulus, MPa	100
Shore D Hardness	30
DSC Melting temperature, °C	163
Volume Resistivity, Ω cm	3×10^{16}
Dielectric Strength, kV/mm	46
Dielectric Constant (1 KHz)	2.15
Dissipation Factor (1KHz)	0.0003

These are typical property values not to be construed as specification limits

Advancing properties of non crosslinked PP based, low and medium voltage cable design

Applications of grades from *Catalloy* technology in Wire & Cable application - Summary

- **Low temperature resistant for flexible PP jacketing (PVC and PE replacement)**
- **Softness improver for filled/unfilled PE jacketing compounds (good compatibility)**
- **High temperature resistant building block in Halogen Free- Flame Retardant compounds for:**
  - Insulation and Jacketing
  - Low Voltage and Medium Voltage cable
- **Building block for non crosslinked or crosslinked cable compounds (peroxide, silane, e-beam)**
- **Building block for Low Smoke-Halogen Free- Flame Retardant T3 automotive cable (controlled shrinkage, high processing speed)**
- **High filler loading compounds**
- **Building block for thermoplastic compounds**

***Grades from Catalloy* technology: advanced values in use for the cable industry**

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Summary table of grades from *Catalloy* technology reactor grades for Wire & Cables applications

		PHYSICAL		MECHANICAL				THERMAL			Electrical		Specific properties features
		Density	Melt flow rate	Flexural Modulus	Tensile Stress at Break	Tensile Elongation at Break	Shore D Hardness	Tg DMTA	Vicat Softening Temp. 10N	Tm	Volume Resistivity	Dielectric Strength	
		23°C	230°C/2,16 kg										
TEST METHOD		ISO 1183	ISO 1133	ISO 527	ISO 527	ISO 527	ISO 868	Internal Method	ISO 306/A50	ISO 11357-3	ASTM D257	ASTM D149	
UNIT		g/cm³	g/10 min	MPa	MPa	%	Points	ºC	ºC	ºC	Ohm-cm	kV/mm	
***Catalloy* reactor grades**													
Softell	CA7469A	0.88	0.5	130	7	500	87 (Sh.A)	-40	50	142	7×10^{16}	47	High Flexibility, Low Tg
Softell	CA 02 A	0.88	0.6	30	10	500	75 (Sh.A)	-25	41	142	9×10^{16}	46	Very high flexilbility, filler loading
Hifax	CA 10 A	0.88	0.6	90	11	500	30	-25	60	142	4×10^{16}	46	High flexibility and good tensile performance
Hifax	CA 7441 A	0.88	0.8	85	12	500	30	-25	56	163	3×10^{16}	46	Combination of excellent thermal properties and flexibility
Hifax	CA 12 A	0.88	0.8	330	13	550	36	-45	78	163	3×10^{16}	48	Good balance between hardness and thermal properties
Hiflex	CA 7700 A	0.88	1,4	170	10	450	33	-45	75	142	6×10^{16}	49	Very low Tg, flexibility and thermal resistance
Hiflex	CA 7800 A	0.88	1,2	210	11	450	35	-45	85	163	6×10^{16}	49	Very low Tg, flexibility and thermal resistance
Softell	CA 7320 A	0.88	2,1	200	10	500	32	-40	62	163	-	-	Combination of excellent thermal properties and flexibility
Hifax	CA207A	0.89	7,5	550	22	700	46	-35	94	163	6×10^{16}	48	Low Tg, Low shrinkage
Hifax	CA212A	0.88	8	80	10	600	30	-25	56	142	3×10^{16}	45	High flexibility and good tensile performance
Hifax	CA 60 A	0.88	15	80	10	600	30	-25	56	142	3×10^{16}	45	High flexibility and good tensile performance, high flow

NB=No Break

These are typical property values not to be construed as specification limits

Grades from *Catalloy* technology: building blocks for tailor made properties in cable constructions

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