The miracles of science™

Introducing

DuPont™ ETPV

engineering thermoplastic vulcanizates

Resists Oil and Heat

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October 29, 2003

DuPont™ ETPV

- Description
- Overall Performance
- ETPV Positioning
- Potential Applications
- Grades for Customers Evaluation
- Properties
- Conclusion

DuPont™ ETPV Description

Engineering thermoplastic vulcanizates comprising:

High performance cross linked elastomer

Dispersed in a:

High performance thermoplastic engineering polymer matrix

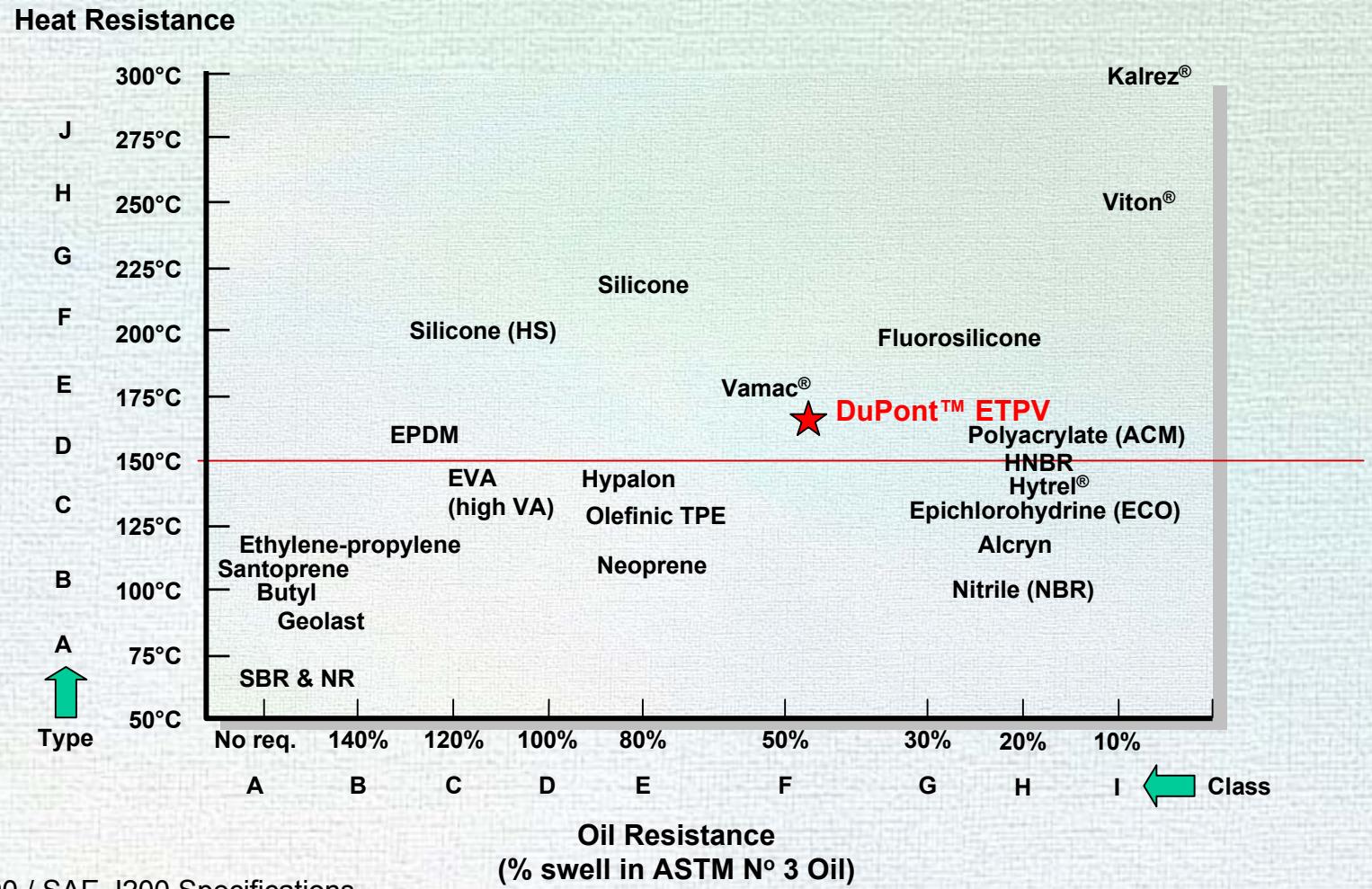
DuPont™ ETPV Description

- **Behaves like a rubber but processes like a thermoplastic**
- **Designed for high performance applications**
  (including those requiring resistance to heat and/or oil)
- **Halogen free**
- **Recyclable**

DuPont™ ETPV Overall Performance

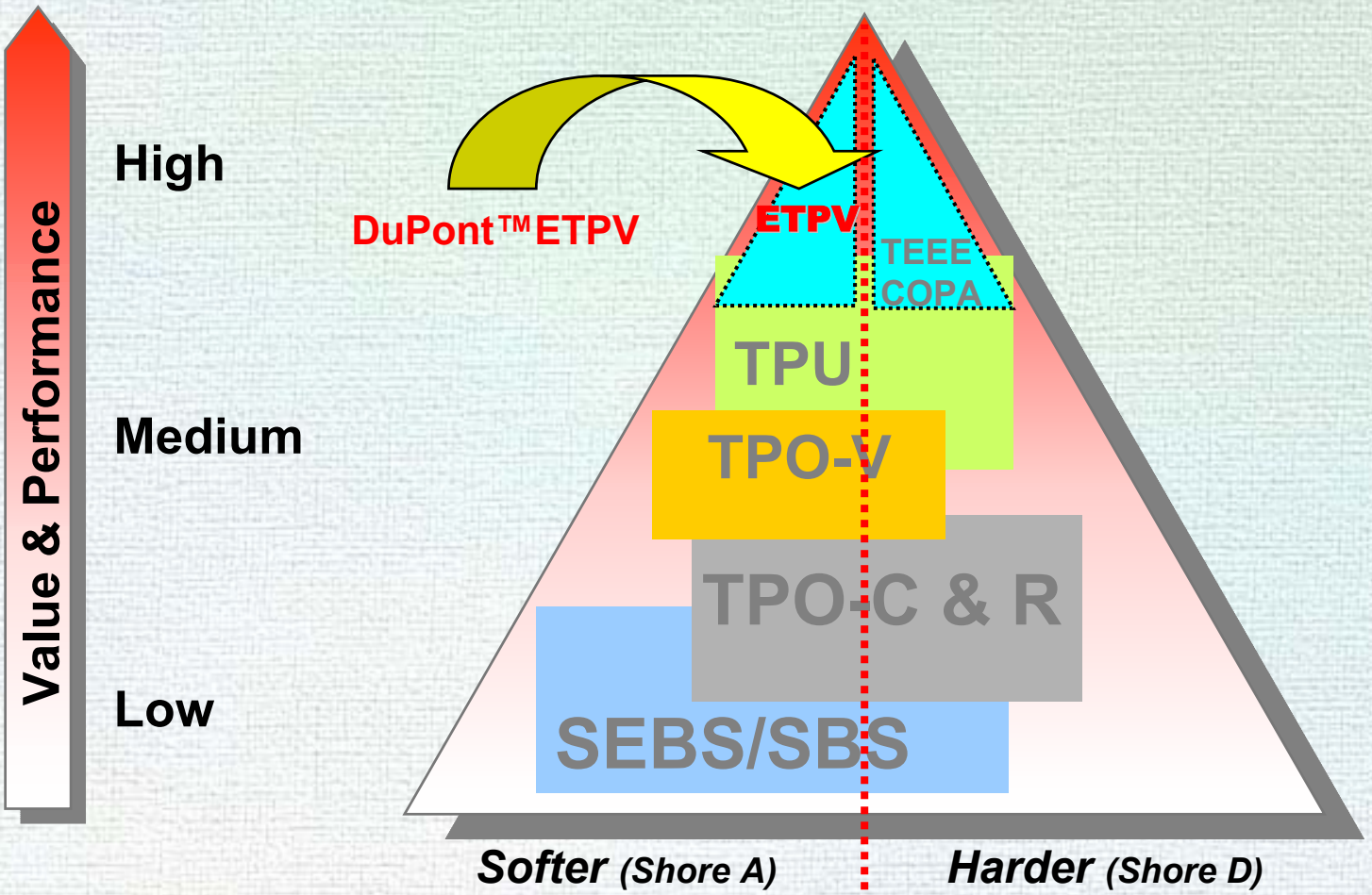
	Depending on the grade:
Hardness:	ShoreA 60 to 90
Tensile strength:	5 to 10 MPa
Elongation at break:	150% to 200%
Compression set 22h at 100°C after annealing (1h, 150°C):	35% to 55%
Compression set 168h at 100°C after annealing (1h, 150°C):	45% to 70%
Service temperature:	-40°C to 160°C and beyond
Resistance to oil no3 (70h, 150°C):	<50% volume change
Brittleness temperature:	-40°C
Soft touch	
Excellent heat aging performance	

DuPont™ ETPV Overall Performance



ASTM D2000 / SAE J200 Specifications.
N.b. The purpose of this chart is to give a general overview. Formulation may affect compound performance.

DuPont™ ETPV vs TPE



DuPont™ ETPV vs TPE

DuPont™ ETPV vs

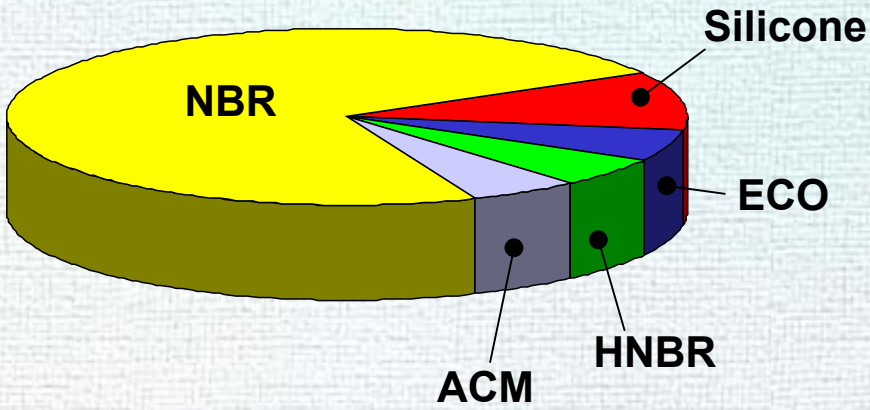
✦ PA11 / 12	Higher flexibility (rubber like) Better chemical resistance
✦ TPU	Better chemical resistance Better compression set
✦ TEEE	Softer (Shore A) Better chemical resistance Better thermal resistance Better compression set

DuPont™ ETPV vs Rubber

Thermoset Rubbers (e.g. ECO, HNBR, NBR) **vs** **DuPont™ ETPV:**

- Thermoplastic Processing
- Oil resistance
- Heat resistance
- Flexibility
- Compression Set
- Chemical resistance

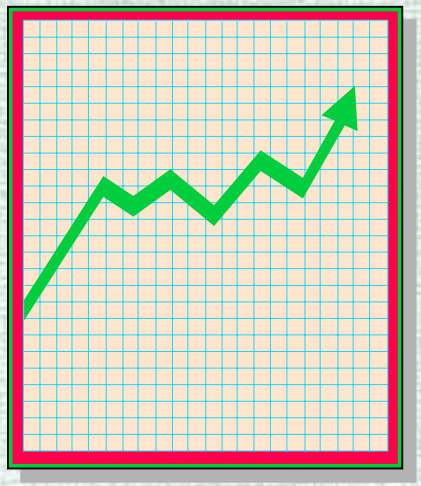
Global Rubber Market Opportunity (275ktpa)



Current Trends for the Rubber Market

- **Automotive**
  - **Largest market, biggest opportunity**
  - **Needs:**
    - Resistance to higher temperatures
    - Withstand more aggressive chemicals
    - Without sacrificing flexibility
- **Consumer/industrial**
  - **Soft touch, fluid seals, hose and tubing**
  - **Needs:**
    - Adhesion in over molding
    - Corrosion resistance

TPE Replacement of Conventional Thermoset Rubbers



- **Replacement driven by**
  - Performance properties
  - Recyclability
  - Ease of processing
- **Gains in TPE sales**
  - Consistently outpaced the general economy
  - Mainly as a result of replacing rubber
- **Recent trends (between 1998 and 2002)**
  - Sales in technical applications increased by about 18%
  - TPEs expected to grow 5.2% per year, reaching $1.3 billion

Source: Fredonia Group

DuPont™ ETPV vs TPE and Rubber

- **Higher performance than leading TPVs and TPEs**
  - Withstand higher temperatures
  - Greater resistances to hydrocarbons
- **Performance/cost advantages over thermoset rubbers**

DuPont™ ETPV Advantages

- **Composition**
  - High performance cross linked elastomer
  - High performance thermoplastic engineering polymer matrix
- **Process like thermoplastics**
  - Low part cost
  - Design freedom
  - Recyclability
- **Properties**
  - Elastomer phase provides high heat resistance, low hardness, creep resistance
  - Thermoplastic phase provides flex life, low temperature toughness, oil/grease resistance

How DuPont™ ETPV stack up…

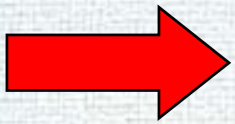
To rubbers	*To TPEs*	*To traditional TPVs*
◆ Higher tensile strength ◆ Recyclability ◆ Processability on standard thermoplastic equipment	◆ Better compression set ◆ Higher service temperature ◆ Lower hardness	◆ Better oil resistance ◆ Higher service temperature: +30°C or more ◆ No halogens

Where DuPont™ ETPV can work for you

- **Process like thermoplastics**
  - Injection molding, 2K molding, blow molding
  - Extrusion: high-speed, no cure
- **Automotive applications**
  - Under hood hoses, body plugs, CVJ boots, NVH applications
  - Hose example: tight bend radius like rubber plus low-temp
- **Other**
  - Wherever superior material performance is needed

DuPont™ ETPV Main Drivers

- Temperature resistance
- Heat aging properties
- Chemical and oil resistance
- Flexibility (rubber like)



Cost saving vs cured rubber (ECO, HNBR, Silicones)

DuPont™ ETPV Potential Applications

Where following families of polymers are used:

- **High performance thermoset rubbers such as ECO, silicone, ACM/AEM, HNBR or NBR**
- **High performance TPEs**

Potential Applications

Automotive ducts

Turbo ducts

Potential Applications

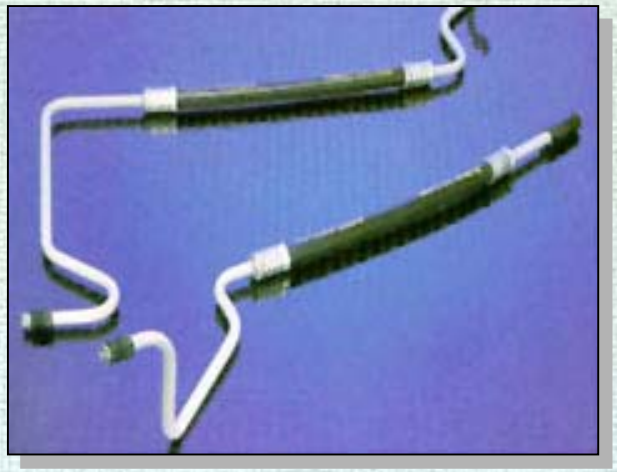
Automotive hoses

Requirements:

- Oil resistance
- Heat resistance
- Softness

Ventilation hoses

Oil cooler hoses



Potential Applications

CVJ boots

Hot side / inboard boots require a soft material that withstands 150°C continuous and 170°C peak temperatures.

Potential Applications

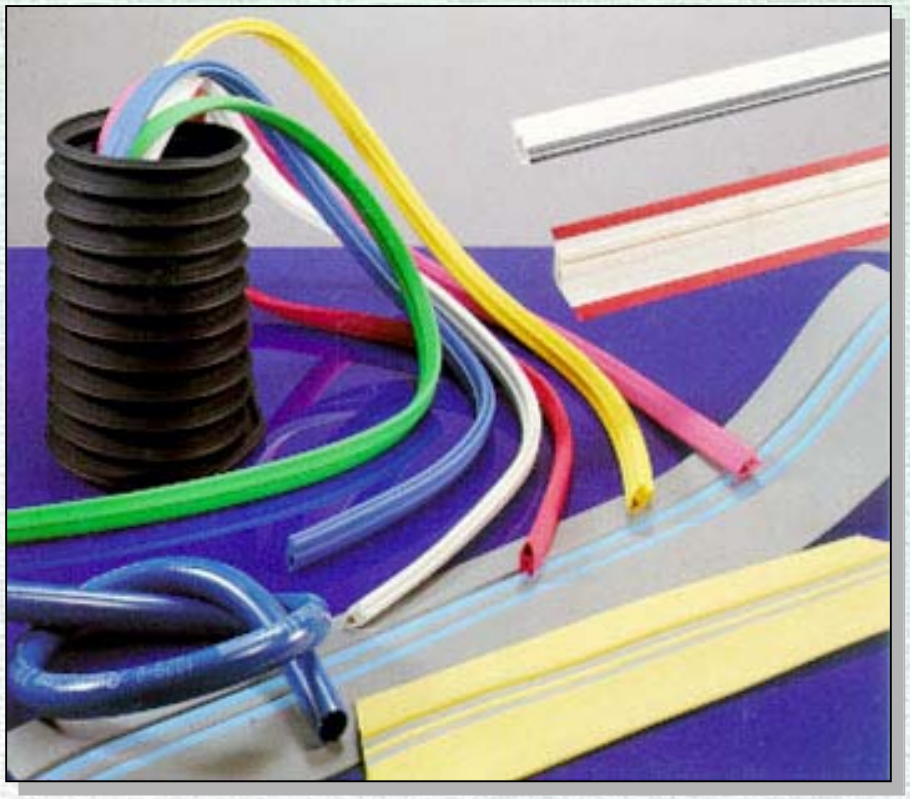
Automotive body plug

Requirements:

- Heat resistance
- Softness

Potential Applications

Sealing profiles



Potential Applications

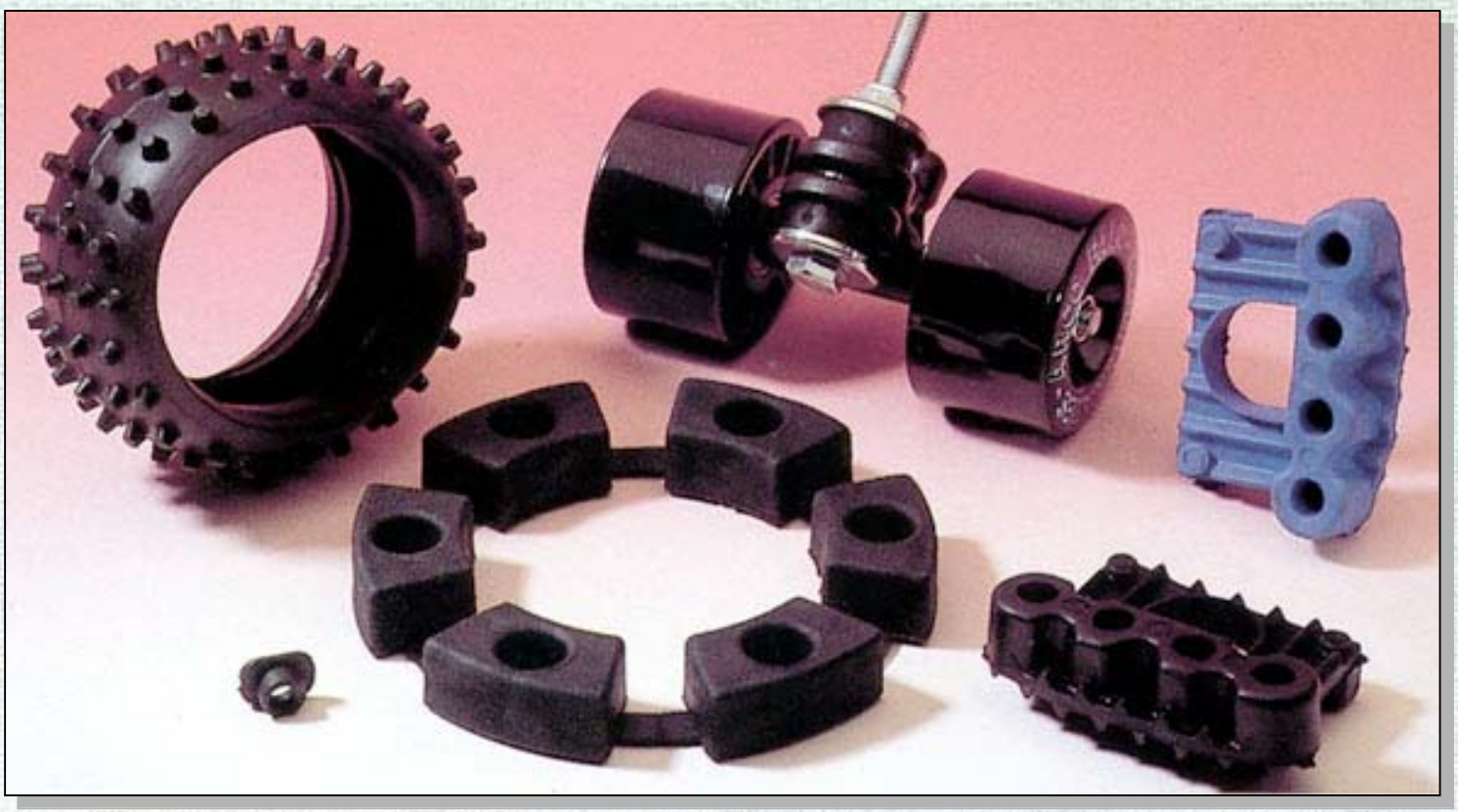
Electrical products

Potential Applications

Molded parts with “hard-soft” combinations

Potential Applications

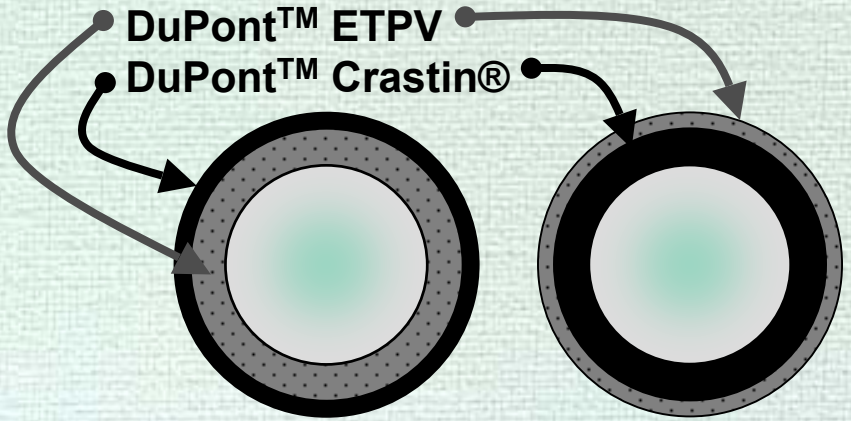
Molded parts for automotive, industrial, appliance and sporting products



Potential Applications

Others

Example of hose / duct (co-ex):



- Co-extruded hoses
- 2 - layer BM ducts
- Fuel line covers for automotive
- Engine mounts and NVH applications
- High pressure hoses for industrial applications

DuPont™ ETPV

Grades for customers evaluation

- **Standard Grades**
  - ETPV60A01 NC010 (extrusion, BM and 2K molding)
  - ETPV60A01L NC010 (injection molding)
  - ETPV90A01 NC010
- **Heat Stabilized Standard Grades**
  - ETPV60A01HS NC010 (extrusion, BM and 2K molding)
  - ETPV60A01HSL NC010 (injection molding)
  - ETPV90A01HS NC010
- **Black concentrate** can be provided for cube blending
  - Hytrel® 40CB (add 2%)
- **Packaging:** Granules in 25kg bags

DuPont™ ETPV

Physical and mechanical Properties

		ETPV60A01	ETPV90A01
Shore A hardness	ASTM D 2241	60	90
Specific gravity	ISO R118	1.08 g/cm^3	1.12 g/cm^3
Tensile strength	ISO 527	5 Mpa	9 Mpa
Elongation at break	ISO 527	160%	190%
Tear strength	ISO 34-1 B/b	16 kN/m	29 kN/m
Compression set, 22h at 100°C after annealing (1h, 150°C)	ASTM D 395-B	35%	55%
Compression set, 168h at 100°C after annealing (1h, 150°C)	ASTM D 395-B	50%	70%
Brittleness temperature	ISO 812	- 40°C	- 40°C
Volume change after 70h in ASTM oil no 3 at 150°C	ASTM D 471	45%	40%

From DuPont™ ETPV Data Sheets

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Heat Aging Properties

Properties after heat aging in air at 150°C

ETPV60A01HS NC010

Property	Test	Unit	1000h	2000h	3000h
Shore A hardness	ISO 868 (15s)	Shore A	62		
Tensile strength	ISO 527	% retention	105	107	113
Elongation at break	ISO 527	% retention	200	162	129

ETPV90A01HS NC010

Property	Test	Unit	1000h	2000h	3000h
Shore A hardness	ISO 868 (15s)	Shore A	88		
Tensile strength	ISO 527	% retention	120	125	140
Elongation at break	ISO 527	% retention	100	63	44

From DuPont™ ETPV Data Sheets

ETPV60A01 NC010 Oil Resistance

ASTM 1 Oil @ 150°C			**70 hrs**	**168 hrs**
Tensile strength	ISO 527	% retention	96	98
Tensile strain at break	ISO 527	% retention	216	106
Tensile stress at 100% strain	ISO 527	% retention	44	91
Hardness	ISO 868 (15 sec)	Shore A	55	54
Volume swell		%	5.2	4.1
IRM #902 Oil @ 150°C			**70 hrs**	**168 hrs**
Tensile strength	ISO 527	% retention	92	92
Tensile strain at break	ISO 527	% retention	210	96
Tensile stress at 100% strain	ISO 527	% retention	42	93
Hardness	ISO 868 (15 sec)	Shore A	47	48
Volume swell		%	26	20
IRM #903 Oil @ 150°C			**70 hrs**	**168 hrs**
Tensile strength	ISO 527	% retention	69	69
Tensile strain at break	ISO 527	% retention	161	170
Tensile stress at 100% strain	ISO 527	% retention	37	40
Hardness	ISO 868 (15 sec)	Shore A	41	35
Volume swell		%	54	60
Engine Oil Cecilia 20 @ 150°C			**70 hrs**	
Tensile strength	ISO 527	% retention	80	
Tensile strain at break	ISO 527	% retention	186	
Tensile stress at 100% strain	ISO 527	% retention	42	
Hardness	ISO 868 (15 sec)	Shore A	50	
Volume swell		%	17	

From DuPont™ ETPV Data Sheets

ETPV90A01 NC010 Oil Resistance

ASTM 1 Oil @ 150°C			**70 hrs**	**168 hrs**
Tensile strength	ISO 527	% retention	102	107
Tensile strain at break	ISO 527	% retention	200	245
Tensile stress at 100% strain	ISO 527	% retention	70	70
Hardness	ISO 868 (15 sec)	Shore A	83	80
Volume swell		%	2.5	2.9
IRM #902 Oil @ 150°C			**70 hrs**	**168 hrs**
Tensile strength	ISO 527	% retention	103	105
Tensile strain at break	ISO 527	% retention	207	228
Tensile stress at 100% strain	ISO 527	% retention	66	68
Hardness	ISO 868 (15 sec)	Shore A	74	79
Volume swell		%	19.5	14
IRM #903 Oil @ 150°C			**70 hrs**	**168 hrs**
Tensile strength	ISO 527	% retention	76	87
Tensile strain at break	ISO 527	% retention	144	181
Tensile stress at 100% strain	ISO 527	% retention	57	61
Hardness	ISO 868 (15 sec)	Shore A	72	70
Volume swell		%	38	35
Engine Oil Cecilia 20 @ 150°C			**70 hrs**	
Tensile strength	ISO 527	% retention	95	
Tensile strain at break	ISO 527	% retention	193	
Tensile stress at 100% strain	ISO 527	% retention	66	
Hardness	ISO 868 (15 sec)	Shore A	74	
Volume swell		%	9.5	

From DuPont™ ETPV Data Sheets

Conclusion

DuPont™ ETPV

engineering thermoplastic vulcanizates

Resist Oil and Heat

A new family of high performance thermoplastic elastomers, combining cured rubber properties with thermoplastic processing capability.

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