Thermoplastic **elastomer** **HYBRAR**™

INDEX

kuraray

What is HYBRAR™ ?

HYBRAR™ is a styrenic block copolymer having a vinyl-polydiene soft block developed by Kuraray Co., Ltd. using its unique isoprene technology.

HYBRAR™ is a series of thermoplastic rubbers which offer high vibration damping properties due to its glass transition temperature (Tg) near room temperature. This opens HYBRAR™ for use in damping applications that are not favorable with Kuraray's SEPTON™ product series.

Hydrogenated HYBRAR™ grades, the 7000 series, exhibit excellent miscibility with polypropylene. As a result, hydrogenated HYBRAR™ /PP blends have excellent transparency. Unlike flexible PVC, they offer good flexibility and mechanical properties without the need for plasticizers while being friendlier to the environment. HYBRAR™ can be processed in various shapes including film, sheet and tube.

Similarly to many rubbers, HYBRAR™ can be vulcanized. Cured HYBRAR™ foams exhibit low compression sets and good elasticity.
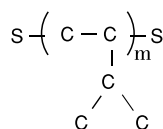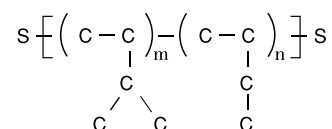
Molecular Structure Model
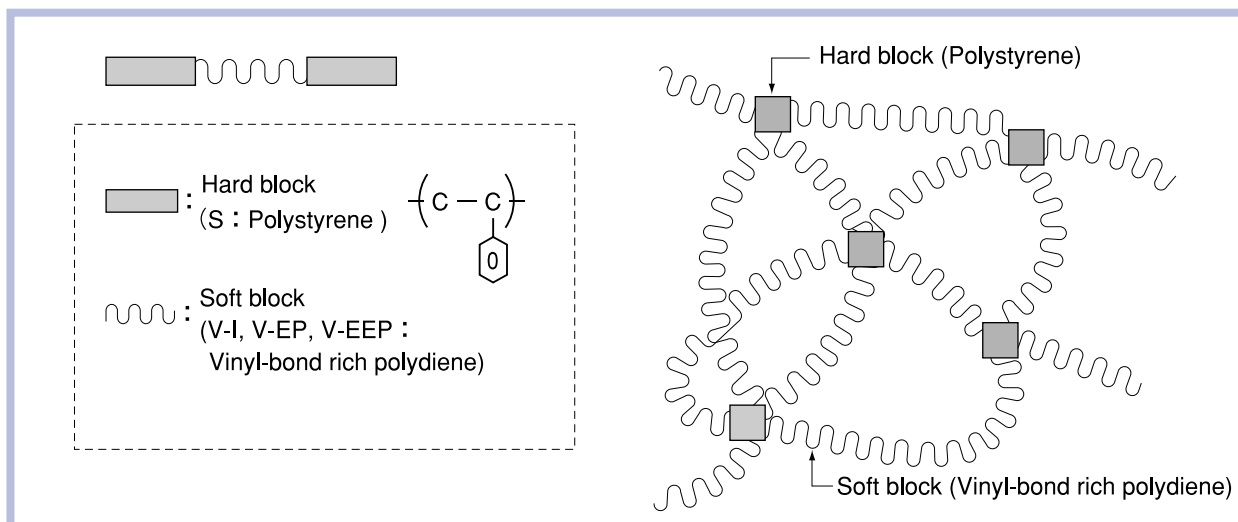
Vinyl-bond rich SIS (5127, 5125)
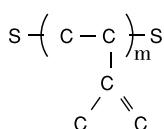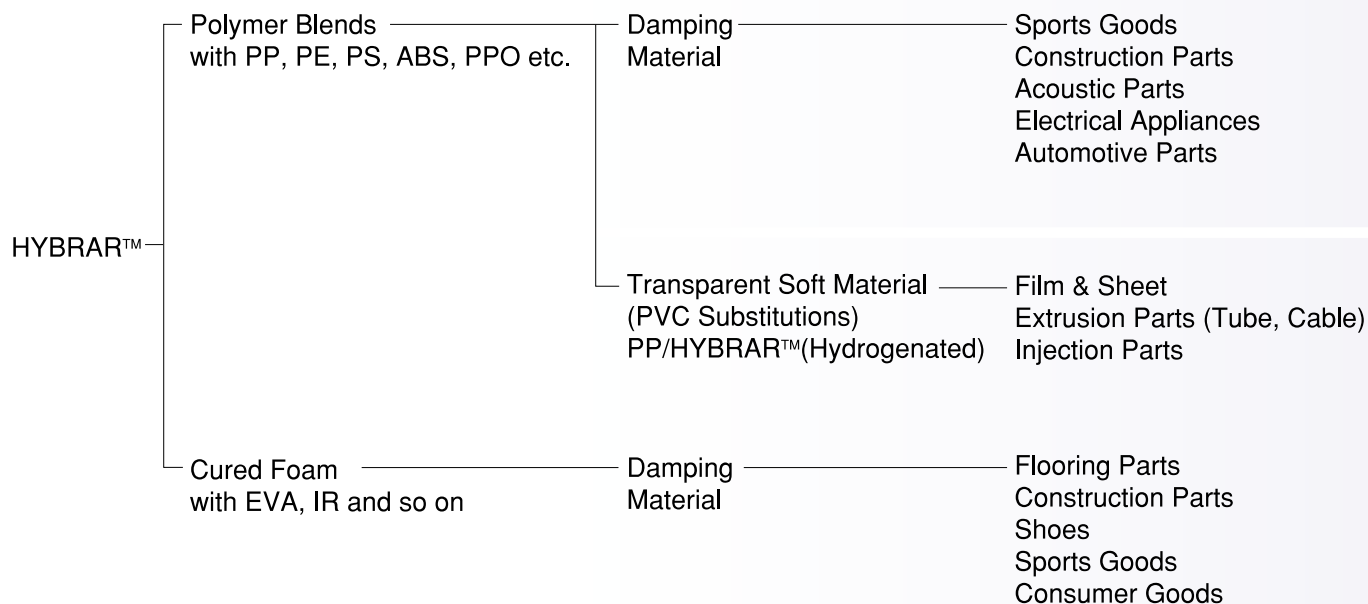
Vinyl-bond rich SEPS (7125)

Vinyl-bond rich SEEPS (7311)

I : Polyisoprene
EP : Hydrogenated Polyisoprene
EEP : Hydrogenated Poly(isoprene/butadiene)

Application Examples of HYBRAR™

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                 Polymer Blends ──────────── Damping ──────────────── Sports Goods
                 with PP, PE, PS, ABS, PPO etc.  Material                Construction Parts
                                                                        Acoustic Parts
                                                                        Electrical Appliances
                                                                        Automotive Parts

HYBRAR™─┤
                                              Transparent Soft Material ──── Film & Sheet
                                              (PVC Substitutions)            Extrusion Parts (Tube, Cable)
                                              PP/HYBRAR™(Hydrogenated)       Injection Parts

                 Cured Foam ──────────────── Damping ──────────────── Flooring Parts
                 with EVA, IR and so on        Material                Construction Parts
                                                                        Shoes
                                                                        Sports Goods
                                                                        Consumer Goods
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HYBRAR™ Grades

	Grade	Type	Styrene Content (wt%)	Peak Temp. of Tanδ (℃)	Glass Transition Temp. (℃)	Specific Gravity	Hardness (Type A)	Tensile Property 100% Modulus (MPa)	300% Modulus (MPa)	Tensile Strength (MPa)	Elongation (%)	MFR 190℃, 2.16kg (g/10min)	230℃, 2.16kg (g/10min)	Solution Viscosity 15wt% (mPa·s)	20wt% (mPa·s)	30wt% (mPa·s)	Physical Form
Unhydrogenated Grades	5127	Vinyl-bond rich SIS	20	20	8	0.94	84	2.8	4.7	12.4	730	5	—	—	—	540	Pellet
	5125	Vinyl-bond rich SIS	20	-3	-13	0.94	60	1.6	2.5	8.8	730	4	—	—	100	650	Pellet
Hydrogenated Grades	7125	Vinyl-bond rich SEPS	20	-5	-15	0.90	64	1.7	2.7	7.1	680	0.7	4	—	55	350	Pellet
	7311	Vinyl-bond rich SEEPS	12	-17	-32	0.89	41	0.6	0.9	6.3	1050	0.5	2	90	240	—	Pellet
Measurement Method			—	—	DSC (Temp. increase by 10℃/min.)	ISO 1183	ISO 7619	ISO 37				ISO 1133		Toluene solution 30℃			—

Unit Conversion : 1MPa＝10.20 kgf／cm² 　　1mPa・s＝1cPs

1） Precautions should be taken in handling and storing. Refer to the appropriate Material Safety Data Sheet for further safety information.
2） In using HYBRAR™, please confirm related law and regulations, and examine its safety and suitability for the application.
3） For Medical, Healthcare and Food Contact applications, please contact your SEPTON™ representative for specific recommendations.
　　HYBRAR™ should not be used in any devices or materials intended for implantation in the human body.

※ The figures, graphs, and charts in this booklet are representative ones measured by KURARAY, and those are without guarantee because each conditions of use are beyond Kuraray's control.

Characteristics

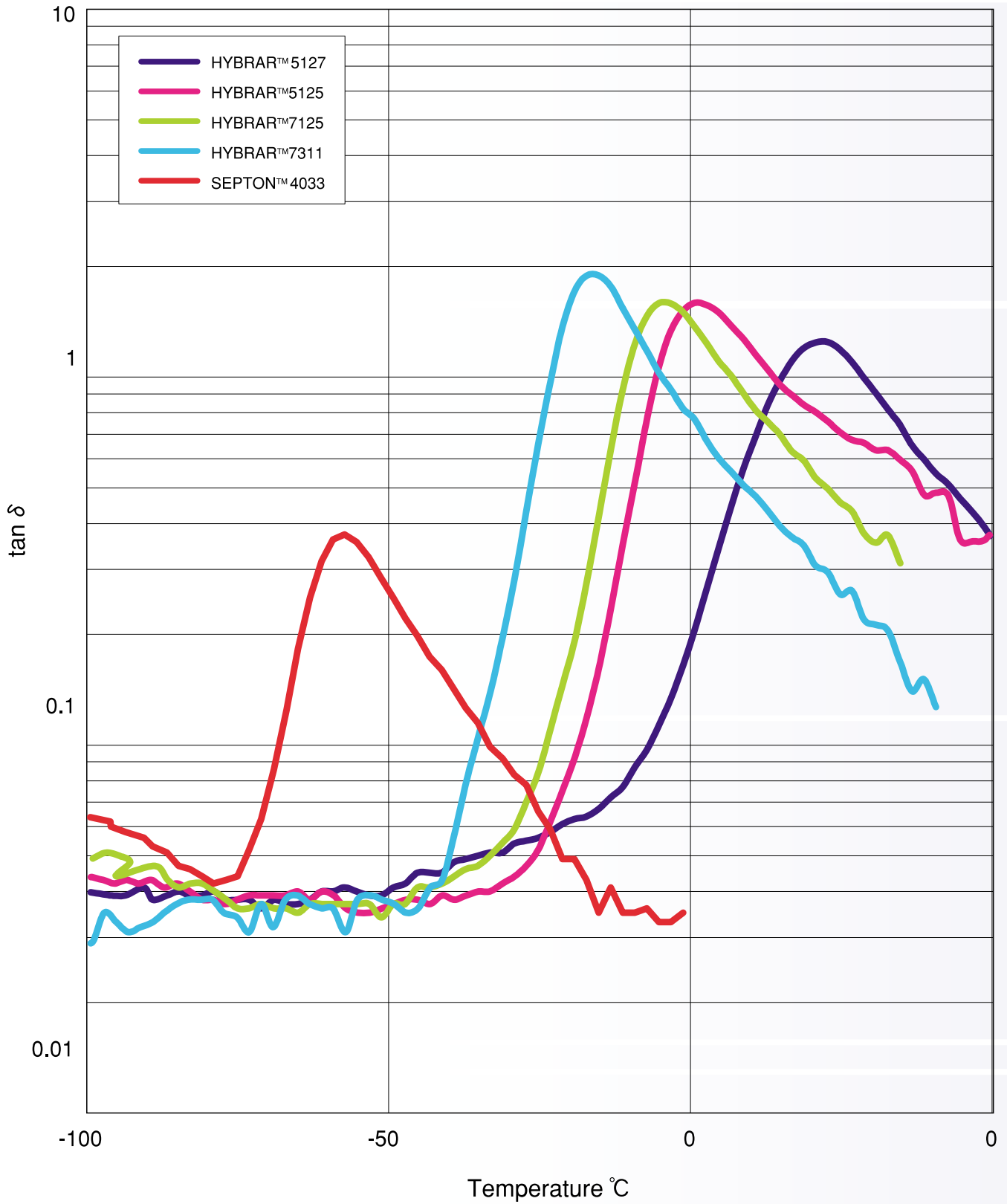| Both(Unhydrogenated,Hydrogenated)	Hydrogenated
High vibration damping at room temperature	Excellent miscibility with polypropylene
High affinity to polyolefins and styrenics	Excellent heat and weather resistance
Can be formed	
Curable like vulcanized rubbers	
Rubber like elasticity	

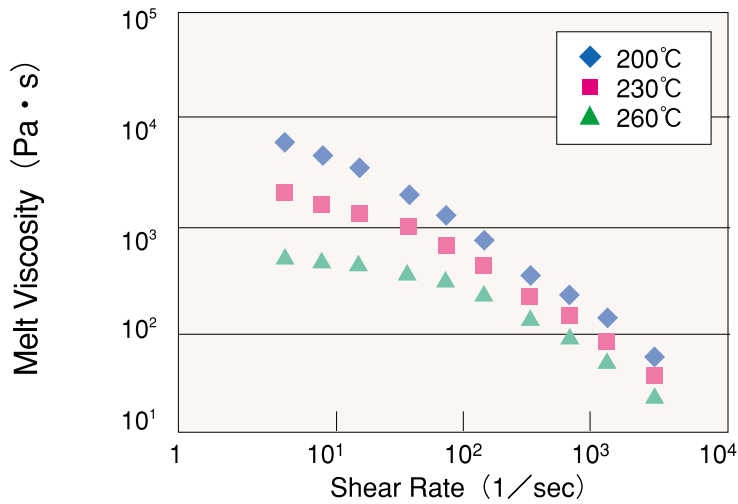# Temperature Dependence of Tan δ

HYBRAR™ Properties Tested by KURARAY CO., LTD.
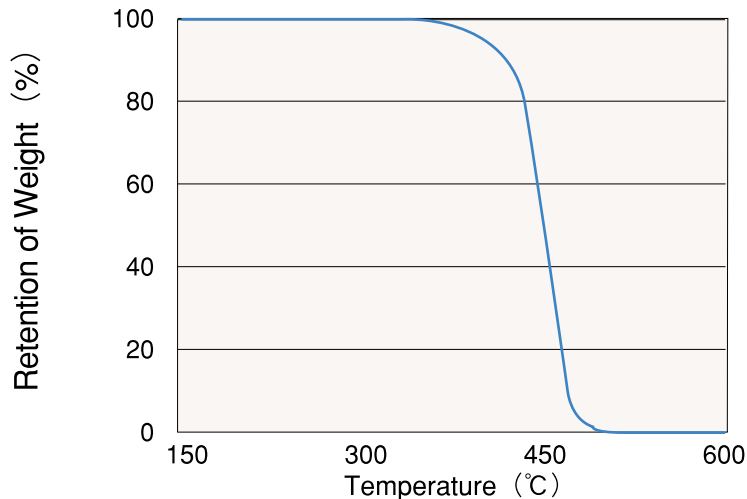
Dynamic Viscoelastic Behavior
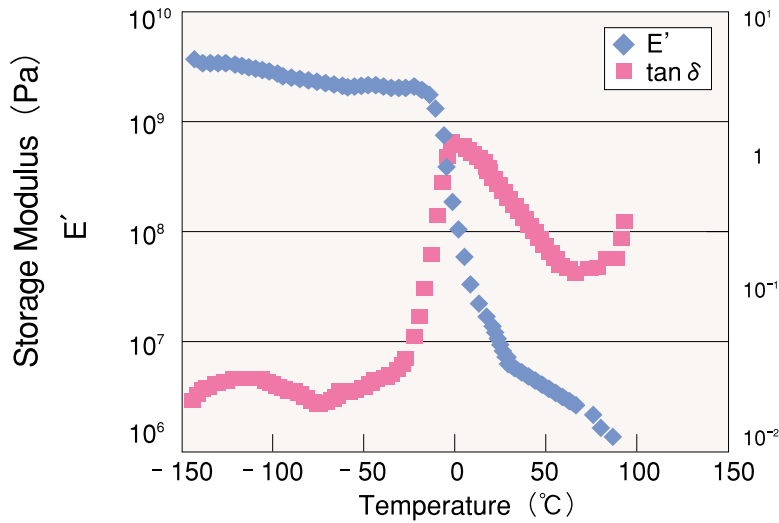
Test Conditions：
HYBRAR™ 7125
Dynamic Rheometer "REOVIBRON DDV-Ⅲ" Tensile mode
Heating Rate 3℃/min.
Frequency 11Hz

Capillary Flow Test

Test Conditions：
HYBRAR™ 7125
Capillary Rheometer "CAPIRO GRAPH"

Heat Resistance

Test Conditions：
HYBRAR™ 7125
Thermo-balance Heat Degradation
Heating Rate 10℃/min.
Nitrogen Atmosphere

Electrical Properties

Item		
Specific Inductive Capacity	10^3 Hz	1.5
	10^4 Hz	1.5
	10^5 Hz	1.5
	10^6 Hz	1.5
Dielectric Loss Tangent	10^3 Hz	—
	10^4 Hz	0.0015
	10^5 Hz	0.0011
	10^6 Hz	0.0012
Dielectric Breakdown Strength	kV/mm	36.9
Volume Resistivity	$\Omega \cdot$ cm	2.0×10^{17}

Test Conditions :
HYBRAR™ 7125
Specific Inductive Capacity : Electrode indirect method (Vacancy mode)
Dielectric Breakdown Strength : JIS K-6911 Voltage Rising Rate 2kV/sec
Volume Resistivity : Measured 1min. after applying DC 500V (at 20℃)

Combustion Test

Combustion Gas		Amount Formed	Detection Limit
SOx(reduced to SO$_2$)	(mg/g)	not detected	0.1
NOx(reduced to NO$_2$)	(mg/g)	not detected	0.5
HCl	(mg/g)	not detected	0.1
HCN	(mg/g)	not detected	0.05
NH$_3$	(mg/g)	not detected	0.1
CO	(mg/g)	140	10
CO$_2$	(mg/g)	350	10
Gross Calorific Value	(J/g)	45000	

Test Conditions:
HYBRAR™ 7125
Combustion gas JIS K-7217 (Combustion condition A)
Gross Calorific Value JIS M8814 Calorimeter

Solubility Data

Soluble	Partially Soluble	Insoluble
Petroleum Benzine Toluene Hexane Cyclohexane Chloroform Carbon Tetrachloride Carbon Disulfide Tetrahydrofuran	Ethyl Acetate Methyl Ethyl Ketone	Methanol Ethanol Acetone Water Dimethyl Formamide

Test Conditions :
HYBRAR™ 7125
Put 10wt% of polymer into each solvent and vibrate for two days at the room temperature.
The solubility is judged by the appearance.

HYBRAR™ Applications ～Polymer Blends～

（1）Plastic/HYBRAR™ Blend

HYBRAR™ can be blended with various plastics to produce materials which exhibit excellent vibration damping properties. Some blends using HYBRAR™ 5127 and their physical properties are depicted below:

Polystyrene/HYBRAR™ Blend

Tested by KURARAY CO.,LTD.

| （wt %）	1	2	3	4
Formulation				
Polystyrene	100	90	85	80
HYBRAR™5127		10	15	20
Physical Properties				
Evaluation of Damping Properties				
Tan δ Loss Factor　　　（0℃）	0.033	0.044	0.047	0.049
（25℃）	0.035	0.051	0.075	0.115
（40℃）	0.037	0.045	0.063	0.094
Loss Factor (Degree of Damping)	0.016	0.023	0.040	0.068
Mechanical Properties				
Hardness　　　　　　（Type-D）	83	80	76	74
Tensile Modulus　　　（MPa）	2600	2300	2200	1900
Tensile Strength　　　（MPa）	49	51	47	43
Elongation　　　　　　（％）	13	18	21	17
Flexural Modulus　　　（MPa）	2600	2300	2100	1700
Flexural Strength　　　（MPa）	74	34	28	23

Conditions

Blended with Twin Screw Extruder at 200℃

Test samples molded with Injection Molder. (Cylinder at 200℃, Mold at 60℃)

Evaluation of Damping Properties:Tanδmeasured with Rheovibron (Dynamic Viscoelastometer, Orientec) at 110Hz

Loss Factor(Degree of Damping) measured by resonance method with a cantilever beam

The vibration damping behavior of the PS/5127 blend, when struck by a steel ball, is shown below.


PS＝100

PS /5127＝85/15
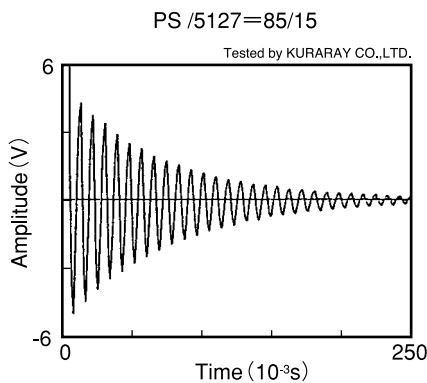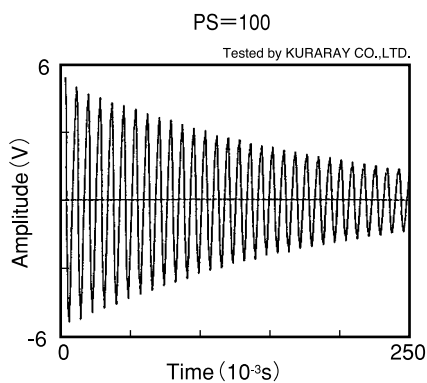
（2） HYBRAR™ based filler compounds

Damping compounds can be produced from the combination of HYBRAR™ and inorganic fillers such as mica, graphite, calcium carbonate,etc.

（parts by weight）	
Formulation	
HYBRAR™5127	70
Polybutene	30
EVA	20
Mica	150
Light Calcium Carbonate	150
Calcium Stearate	4
Carbon Black(GPF)	4
Damping Properties(Reovibron:11Hz)	
Tan δ　　　at 0℃	0.54
25℃	0.73
40℃	0.51
Mechanical Properties	
Tensile Strength　　MPa	3.6
Elongation　　　　　%	90
Hardness　　　Shore A	89
Specific Gravity　　────	1.83

（Tested by KURARAY CO.,LTD.）

（1MPa＝10.20kgf/cm²）
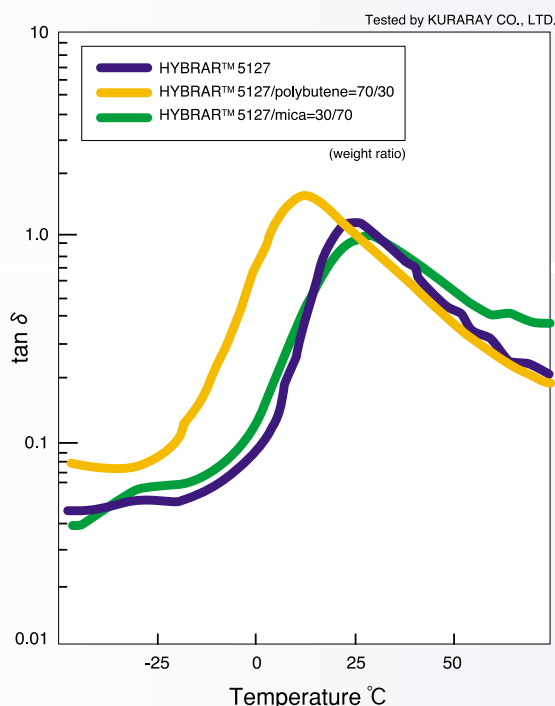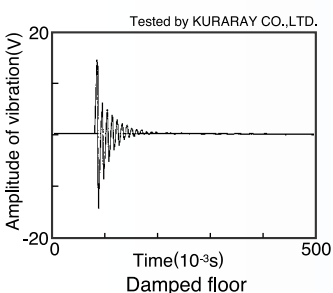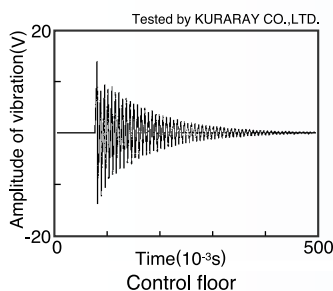
Application to a Wooden Floor
Test Specimen:Control Floor-Two Layer Plywood(Thickness=2.4mm&5.3mm)
　　　　　　　Damped Floor-Three Layer Plywood/Damping Compound/ Plywood
　　　　　　　　　　2.4mm　　　　/　　0.5mm　　/　5.3mm
Test Method:Damped Oscillation Curve was measured by the resonance
　　　　　　method with a cantilever beam at 26℃

Control floor (Tested by KURARAY CO.,LTD.)

Damped floor (Tested by KURARAY CO.,LTD.)

Tested by KURARAY CO., LTD.
HYBRAR™ 5127
HYBRAR™ 5127/polybutene=70/30
HYBRAR™ 5127/mica=30/70
(weight ratio)

（3） SEPTON™ and HYBRAR™ combination compound

HYBRAR™ can be blended with olefins and/or SEPTON™ to produce soft compounds which exhibit excellent vibration damping properties. Some compounds using HYBRAR™ 5127 and their physical properties are depicted below:

（parts by weight）		1	2	3
Formulation				
SEPTON™ 4055		100	100	100
HYBRAR™ 5127			100	100
Process Oil		180	100	60
Polypropylene		50	40	40
Physical Properties				
Resilience	（%）	40	17	12
Hardness	（Type A）	48	51	61
Tensile Modulus	（MPa）	0.8	1	1.4
Tensile Strength	（MPa）	9.3	10.3	13.9
Elongation	（%）	990	850	800
Compression Set				
25℃×22h	（%）		15	17
70℃×22h	（%）	41		59
MFR（230℃, 21N）	（g/10min）	5	17	6

Tested by KURARAY CO.,LTD.

Mixing Condition: Twin Screw Extruder at 210℃
Molding Condition: Injection Molding (Cylinder at 210℃, Mold at 50℃)
Resilience: ISO 4662 Lupke Type Rebound Resilience Tester
=Hr/Ho x100 (Hr: Rebound Height, Ho: Fall Height)

Red: HYBRAR™ based compound
Blue: Common rubber based compound

HYBRAR™ Applications
～PP / HYBRAR™ (Hydrogenated) Blends～

Hydrogenated HYBRAR™ grades (HYBRAR™ 7125 and HYBRAR™ 7311) exhibit excellent miscibility with polypropylene. Unlike flexible PVC, they offer good flexibility and mechanical properties without the need for plasticizers while being friendlier to the environment.

HYBRAR™ 7311 has a lower styrene content and a lower glass transition temperature than HYBRAR™ 7125. As a result, PP/7311 blends are more flexible at room temperature than PP/7125 blends and offer better impact properties at lower temperatures.

PP/7125, PP/7311 Blends

Tested by KURARAY CO.,LTD.

(parts by weight)		1	2	3	4	5	6	7
Formulation								
Polypropylene (Random)		100	90	80	70	90	80	70
HYBRAR™7125			10	20	30			
HYBRAR™7311						10	20	30
Physical Properties								
Hardness	(Type A)	98	98	96	98	94	96	94
	(Type D)	63	55	46	42	54	44	35
Young's Modulus	(MPa)	490	480	250	140	380	140	90
Tensile Strength	(MPa)	37	35	30	30	34	30	28
Elongation	(%)	1400	1400	1400	1600	1400	1600	1700
Impact strength Notched Izod at-20℃	(J/m)	30	32	36	38	45	320	860
Haze (1mm thick film)	(%)	52	49	30	19	52	33	27

Mono Layer（Cast Film）

Tested by KURARAY CO.,LTD.

(wt%)		1		2		3		4	
Formulation									
Polypropylene (Random)		90		85		80		70	
HYBRAR™7125		10		15		20		30	
Mechanical Properties		MD	TD	MD	TD	MD	TD	MD	TD
Tensile Strength	(MPa)	38	35	35	38	37	36	38	30
Young's Modulus	(MPa)	240	230	200	220	140	150	110	100
Elongation	(%)	1090	1130	1000	1200	1270	1170	1150	1090
Optical Properties									
Haze	(%)	3.9		2.8		0.9		0.4	

（Thickness＝50μm）

Comparison of PP/ HYBRAR™ (Hydrogenated) blends and Flexible PVC

	PP / HYBRAR™ (Hydrogenated) Blend	Soft PVC
Halogen Free	○	✕
Plasticizer Free	○	✕
Low Specific Gravity	○	✕
Transparency	○	○
Flexibility	○	○
Heat Resistance	○	○
Weather Resistance	○	○

（○Good　✕Not Good）

Dynamic Viscoelastic Behavior for PP / HYBRAR™ 7125

Tested by KURARAY CO.,LTD.

- PP/ HYBRAR™ 7125 100/0
- PP/ HYBRAR™ 7125 70/30
- PP/ HYBRAR™ 7125 50/50
- PP/ HYBRAR™ 7125 30/70
- PP/ HYBRAR™ 7125 0/100
- PVC (Hs80A)
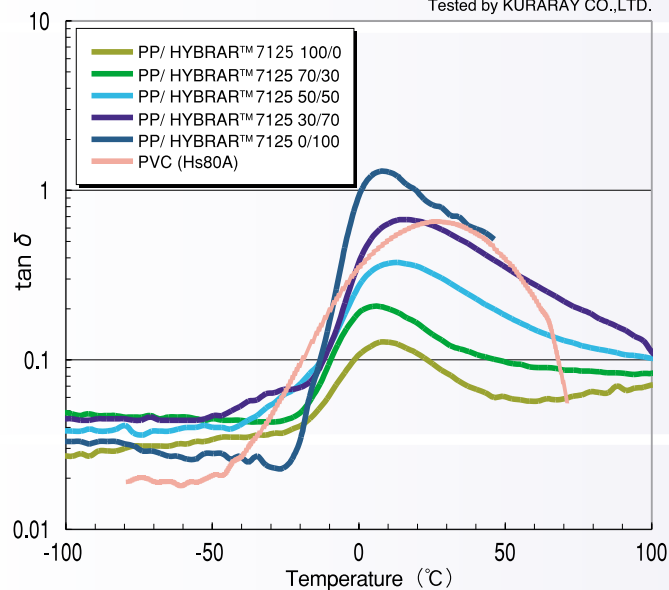
In case of PP/HYBRAR™ 7125=30/70 formulation (——), it shows very similar dynamic viscoelastic behavior to Soft PVC shown as above, and so it has very similar feeling to Soft PVC (——) such as unique slow-recovery property.

HYBRAR™ Applications ～Cured Foam～

Damping foams can be made with HYBRAR™ by using foaming and curing agents. An example is shown below.

Comparison data between conventional EVA foam and HYBRAR™ based foam

Tested by KURARAY CO.,LTD.

(parts by weight)	1	2
Formulation		
EVA（VA Content：19wt%）	100	50
HYBRAR™5127		50
Curing Agent	0.8	0.175
Foaming Agent	3	3
ZnO	2	2
Stearic Acid	1	1
TiO2	4	4
Physical Properties		
Specific Gravity	0.17	0.18
Hardness (ASTM D2240, TypeC, 14℃)	65	66
Compression Set （%）	65	48
Resilience （%）	40	19
Tensile Strength （MPa）	2.1	2.1
Elongation （%）	230	230

Mixing Condition: Kneader and Roll-mill at 100℃～130℃
Curing Condition: Press Molding at 145℃ for 60min. with 14.7 MPa pressure