NOF CORPORATION

1 Introduction

NOF®-ALLOY KA series are the novel type anti-scratch improvers which are exclusively manufactured by NOF CORPORATION based on unique NOF's radical grafting technology. They have the following characteristics.

- NOF®-ALLOY KA series can improve both the anti-scratch and the anti-wear properties of various resins or rubbers, such as PP compound, PC / ABS, PC, ASA, PMMA, TPO and Crosslinked EPDM.
- NOF®-ALLOY KA series can reduce the risk of the squeak noise when they are added into resins or rubbers.

Table 1 About of NOF®-ALLOY KA series

Product name	Appearance	CAS No.	Characteristic
NOF®-ALLOY KA832	Translucent white pellet	Trade secret	-
NOF®-ALLOY KA147	White powder	Trade secret	Low VOC

NOF®-ALLOY KA832

NOF®-ALLOY KA147

Fig.1 Appearance of NOF®-ALLOY KA series

2 Basic properties of NOF®-ALLOY KA series

Table 2 Basic properties of NOF®-ALLOY KA series

Test item			Test method	Unit	KA832	KA147
Mechanical property	MFR[1)]		ISO 1133 (JIS K 7210)	g/10min	20	-[2)]
Thermal properties	TGA[3)]	1% weight loss temp.	JIS K 7120	℃	230	260
		5% weight loss temp.			270	300
	DSC[4)]	Melting point	JIS K 7121	℃	83	70

1) 190 ℃, 2.16kgf

2) Not measured

3) TGA : Thermo Gravimetric Analysis (Rate of temperature rise : 10 ℃/min, N_2 atmosphere)

4) DSC : Differential Scanning Calorimetry (Rate of temperature rise : 10 ℃/min, N_2 atmosphere)

3 Applicable resins and usage of NOF®-ALLOY KA series

Table 3 Applicable resins of NOF®-ALLOY KA series

Product name	PP compound 1)	PC/ABS	PC2)	ASA	PMMA2)	TPO	Crosslinked EPDM
KA832	◎	-	-	○	○	◎	○
KA147	○	○	○	○	-	-	-

1) PP compound.....b-PP/EPR/Talc = 70/10/20 wt.%

2) Non-transparent application

3) ◎: Excellent, ○: Good, - : Not measured

Table 4 Compounding condition that NOF®-ALLOY KA series are added

Blending method	Resin	Condition
Twin screw extruder	PP compound, TPO	(Cylinder) 190～220 ℃
	PC/ABS, PC, ASA, PMMA	(Cylinder) 240～250 ℃
Bunbury mixer	Crosslinked EPDM	(Can body) 180 ℃
Roll		(Kneading time) 3 min

Table 5 Molding condition that NOF®-ALLOY KA series are added

Molding method	Resin	Condition
Injection molding	PP compound	(Cylinder) 190～220 ℃ (Molding) 50 ℃
	PC/ABS、PC、ASA、PMMA	(Cylinder) 240～250 ℃ (Molding) 80 ℃
Extrusion molding	TPO	(Cylinder) 190～220 ℃ (Molding) 50 ℃
Press molding	Crosslinked EPDM	(Press) 180 ℃, 20min

PP..... Polypropylene

PC/ABS ..... Polycarbonate / Acrylonitrile-Butadiene-Styrene

PC..... Polycarbonate

ASA..... Acrylate-Styrene-Acrylonitrile

PMMA..... Polymethyl methacrylate

TPO..... Thermoplastic elastomer olefin

EPDM..... Ethylene propylene diene rubber

4 Evaluation method

Evaluation of anti-scratch property

◆ Test equipment

Scratch tester KK-01 (KATO TECH Co., Ltd.)

◆ Evaluation condition

ISO 19252(ASTM D7027-05)

Incremental load.. ..... 1 – 15 N or 1 – 30 N

Scratch velocity ... . 100 mm/s

Scratch distance.. ..... 100 mm

Tip size..... ..... φ=1.0 mm (Stainless steel ball)

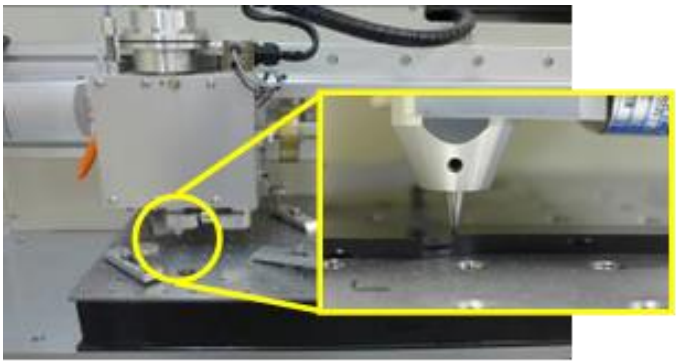

Fig.2 Scratch tester KK-01

◆ Evaluation

The value of anti-scratch property is shown as the load that the initial scratch mark was observed on surface. It is preferred that scratch load is large.

Fig.3 Evaluation of anti-scratch property

Evaluation of anti-wear property (Evaluation of wear test by cloth)

◆ Test equipment

NO416-TMI CROCK METER (YASUDA SEIKI SEISAKUSHO, LTD.)

◆ Evaluation condition

Load..... ..... 1,000 gf (Wear tip area is 2 cm^2.)

Velocity..... ..... 200 mm/s

Round .... 100 times

Counter material.. ..... Cotton cloth

◆ Evaluation

Gloss retention is calculated from initial and after tested gloss.

It is preferred that gloss retention is large.

Gloss retention (%) = After tested gloss / Initial gloss

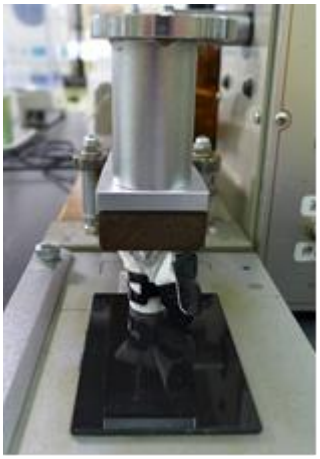

Fig.4 NO416-TMI CROCK METER

Table 6 Evaluation points of anti-wear property

Point	Evaluation result	
1	Attaches wear mark, and remains abrasion powder	***poor***
2	Wear area is 75% or more and less than 100%	
3	Wear area is 50% or more and less than 75%	↕
4	Wear area is 25% or more and less than 50%	
5	Wear area is less than 25%	***good***
6	No wear mark	

Evaluation of squeak noise (Stick-slip test)

◆ Test equipment

STICK-SLIP TEST STAND (ZIEGLER-INSTRUMENTS GmbH)

◆ Evaluation condition (VDA230-206 : German Automobile Industry Association Standard)

Test material..... ..... PP compound
Counter material..... ..... Article leather (PVC)
Load..... ..... 10 or 40 N
Velocity..... ..... 1 or 4 mm/s
Amplitude..... ..... 20 mm
Reciprocation times..... 3 times

◆ Evaluation

The two specimens (big and small) are prepared. Big one (Test material) is reciprocated and rubbed with small one by 3 times. The risk of squeak noise is shown by Risk-Priority-Number (RPN) which is ranked by the 10 stages shown below, (In case of RPN=1～3, it is categorized as No stick-slip risk).

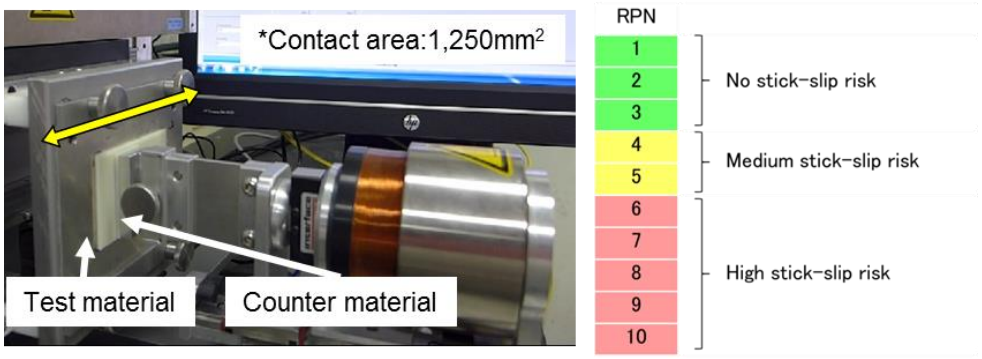

Fig.5 Stick-slip test stand

Evaluation of dynamic friction coefficient

◆ Test equipment

TriboGear TYPE : 14DR (SHINTO Scientific Co., Ltd.)

◆ Evaluation condition

ASTM D1894

Load..... ..... 1 kgf
Velocity..... ..... 600 mm/min
Distance..... ..... 50 mm

Evaluation of mechanical properties

Table 7 Evaluation method of mechanical properties

Evaluation	Resin	Method, condition
Tensile test	PP compound, PC/ABS, PC, ASA, PMMA	ISO 527-1, speed 50mm/min
	TPO, Crosslinked EPDM	ISO 37, speed 500mm/min
Flexural test	PP compound, PC/ABS, PC, ASA, PMMA	ISO 178, speed 2mm/min
Izod impact test		ISO180, 23℃, Notched
HDT* test		ISO 75, Flexural strength 1.8MPa
Hardness test	TPO, Crosslinked EPDM	ISO 7619-1, Type A durometer
Compression set test		ISO 815-1, 23℃ or 120℃, 22h

* HDT : Heat Deflection Temperature

5 Improvement of anti-scratch and anti-wear properties into resins

< About anti-scratch and anti-wear properties >

NOF®-ALLOY KA series can improve the both anti-scratch and the anti-wear properties. Furthermore, even if the thermal stress is added, the improvement of both the anti-scratch and the anti-wear properties are maintained.

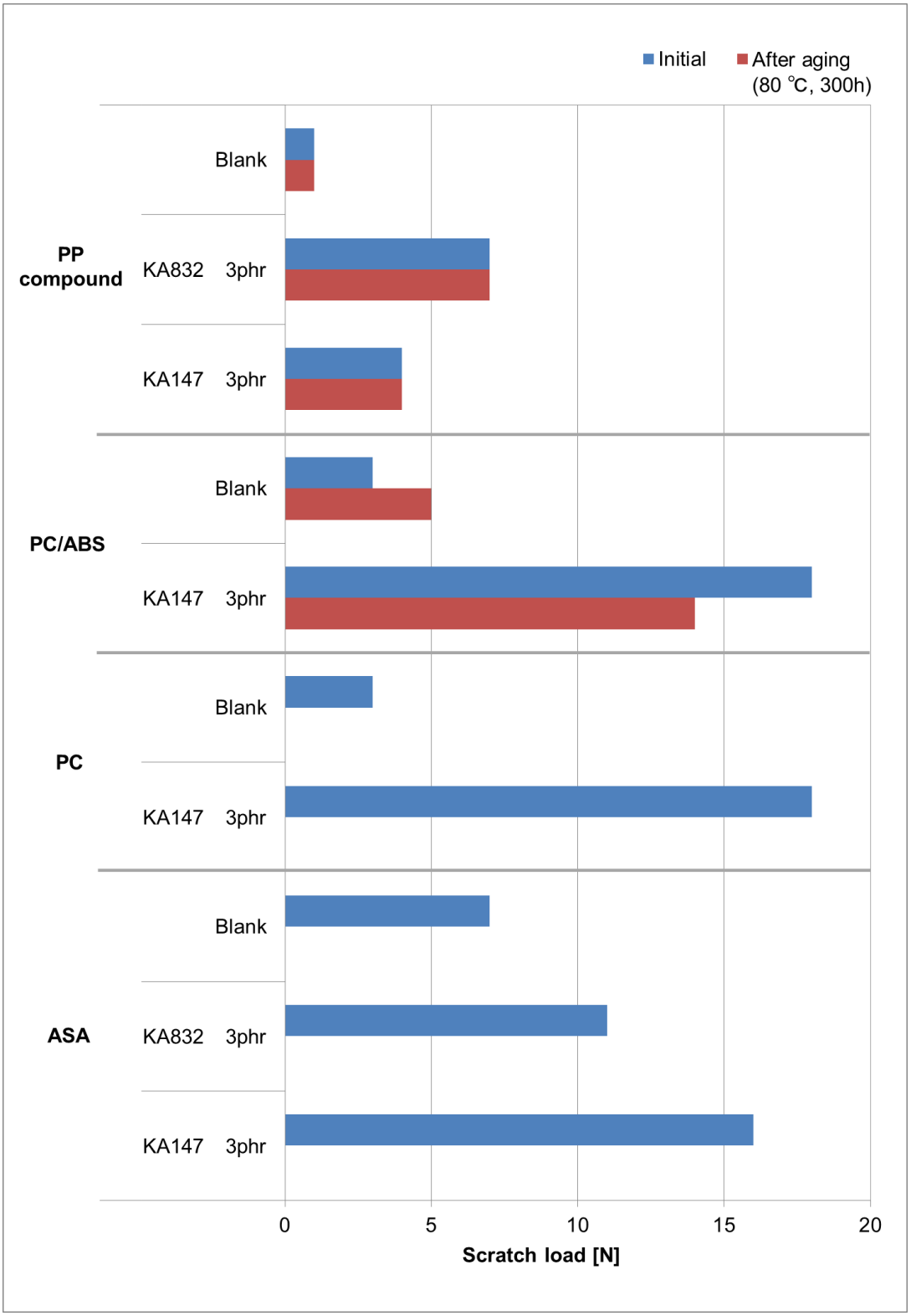

Fig.6 Evaluation of anti-scratch property when NOF®-ALLOY KA series are added

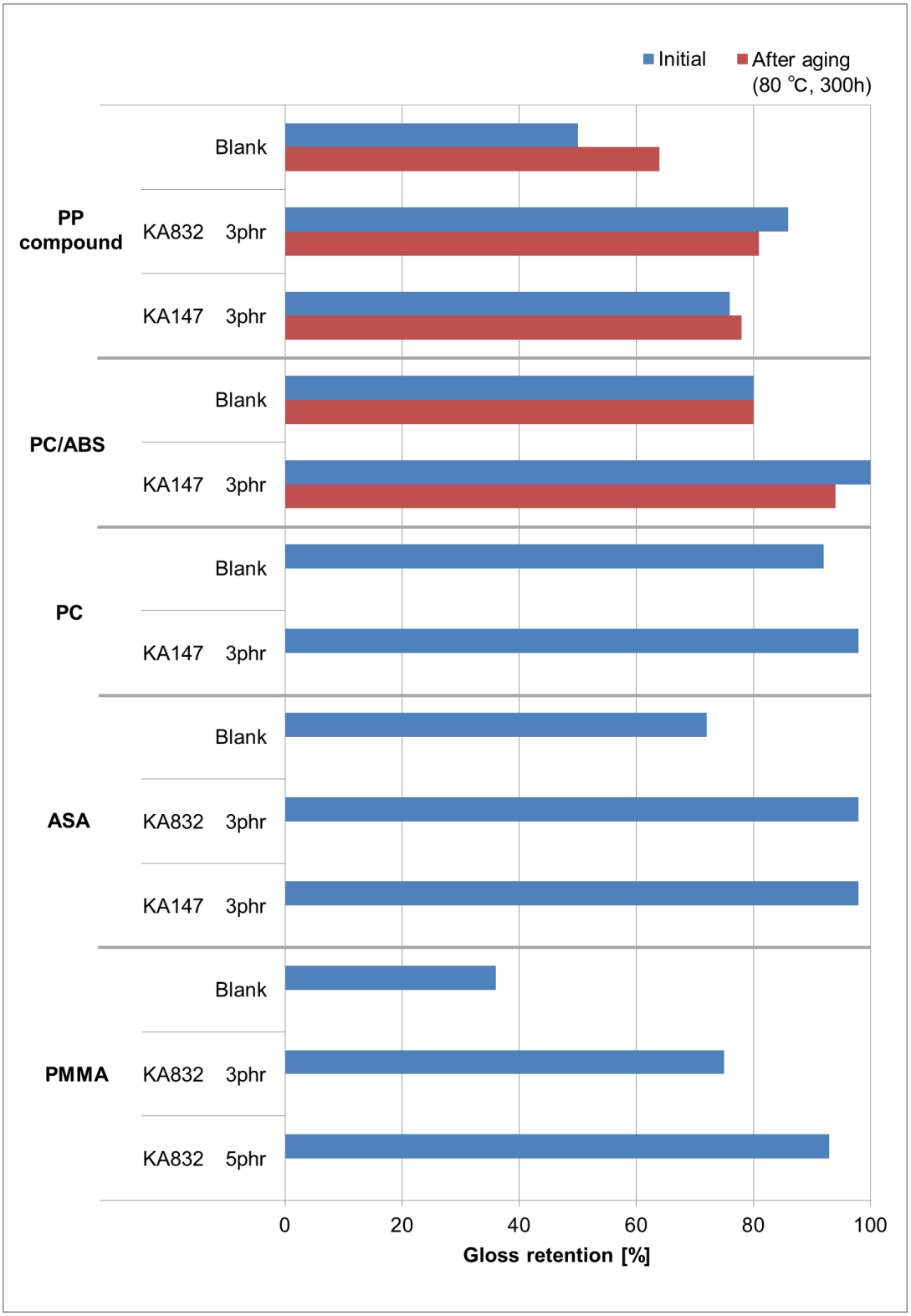

Fig.7 Evaluation of anti-wear property when NOF®-ALLOY KA series are added

NOF®-ALLOY KA832 can improve both the anti-wear property and the tribological property to TPO and crosslinked EPDM.

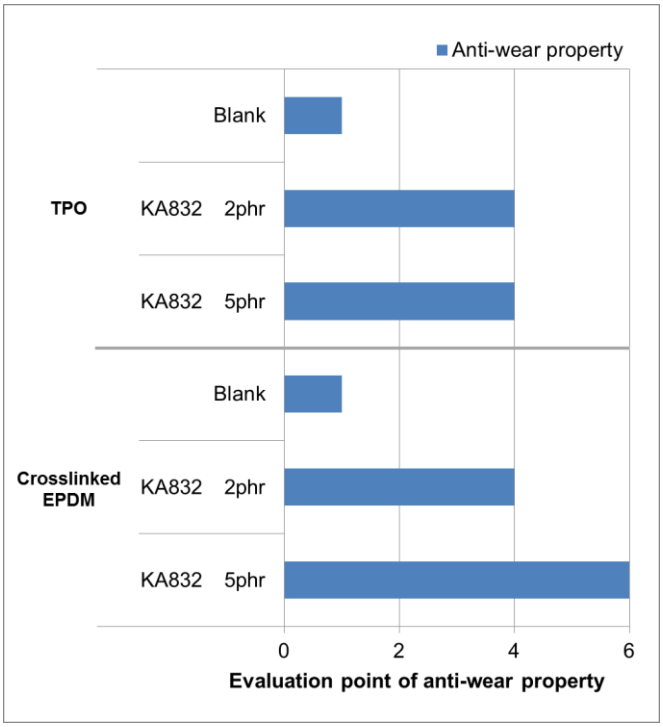

Fig.8 Evaluation of anti-wear property of TPO or crosslinked EPDM with NOF®-ALLOY KA 832

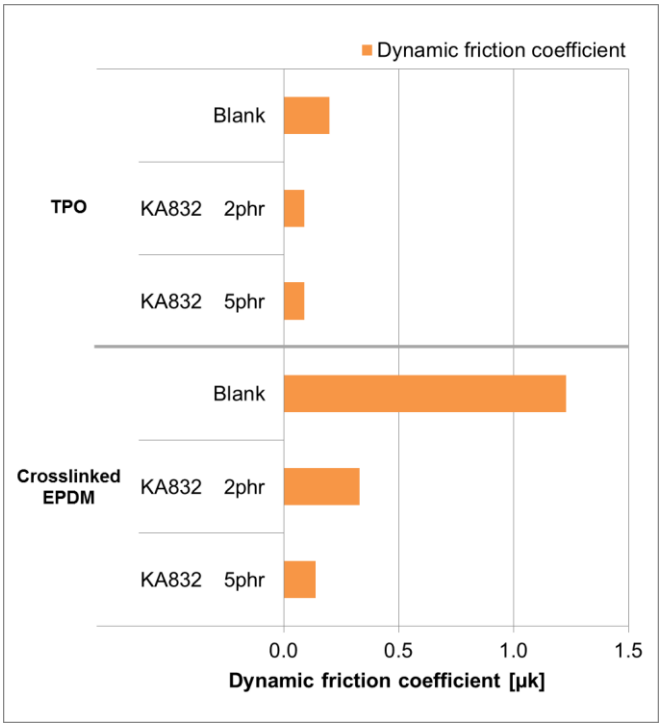

Fig.9 Evaluation of dynamic friction coefficient of TPO or crosslinked EPDM with NOF®-ALLOY KA 832

6 Use in dry blend process when NOF®-ALLOY KA832 added into PP compound

< About use in dry blend process >

NOF®-ALLOY KA832 can improve both the anti-scratch and the anti-wear properties even if it is mixed by the dry blend process. When dry blending, please dry the base resin as necessary. NOF®-ALLOY KA832 does not need to dry.

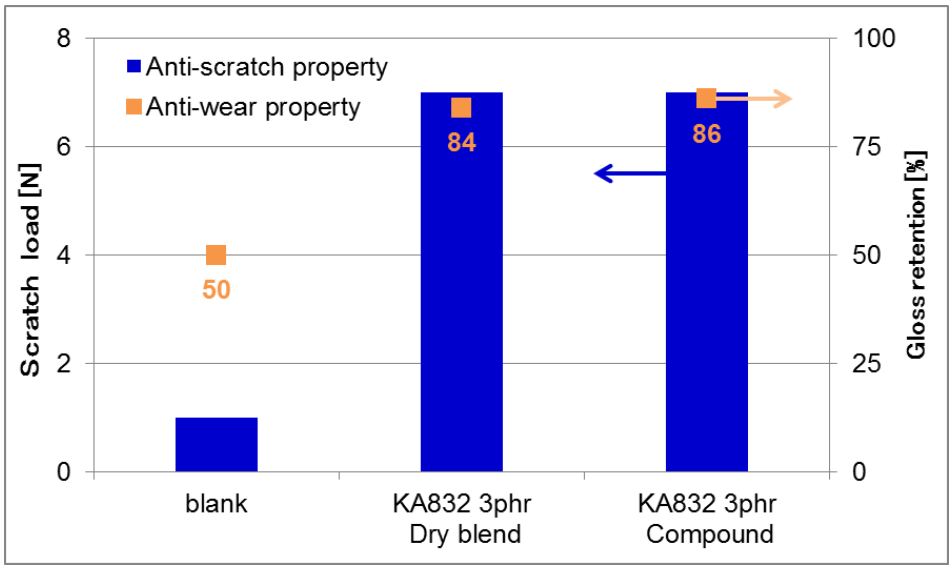

Fig.10 Evaluation of anti-scratch and anti-wear properties in dry blend process

7 Squeak noise prevention when NOF®-ALLOY KA series added into PP compound

< About squeak noise prevention >

By adding NOF®-ALLOY KA series into PP compound, the risk of squeak noise can be reduced when it is rubbed with the artificial leather (PVC).

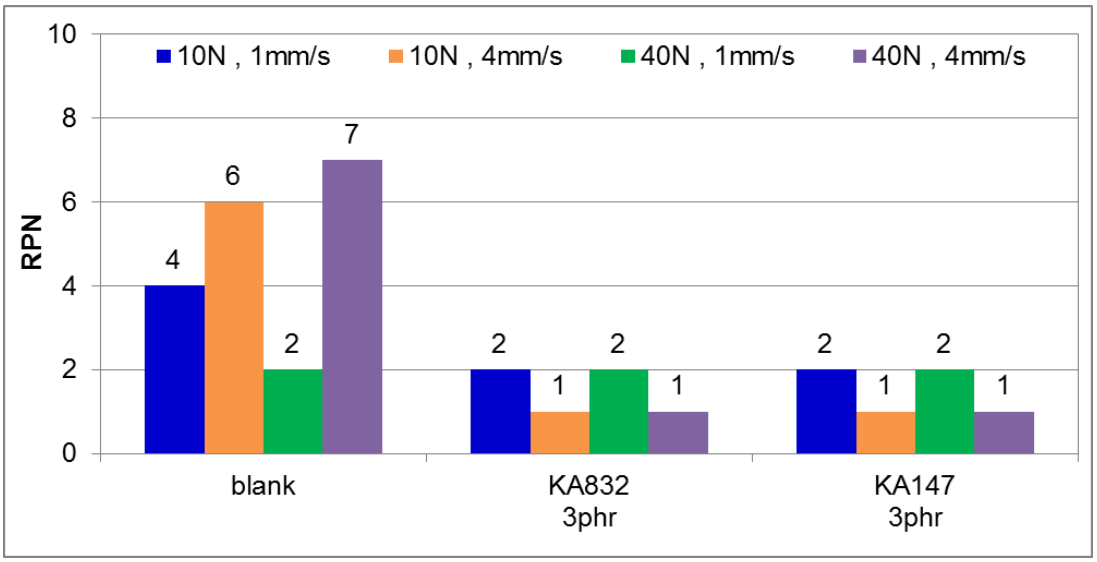

Fig.11 Evaluation of squeak noise

8 Mechanical properties of each resins containing NOF®-ALLOY KA series

The mechanical properties of each resin with NOF®-ALLOY KA series are shown in table 8 and table 9.

Table 8 Mechanical properties when NOF®-ALLOY KA series are added into resins

Resin	KA832	KA147	Tensile strength	Flexural modulus	Izod impact	HDT
	Phr	phr	MPa	MPa	kJ/m^2	℃
PP compound	0	0	21	1,900	5	-
	3	0	20	1,700	8	-
	0	3	19	1,700	5	-
PC/ABS	0	0	49	2,200	NB*	101
	0	3	46	1,900	NB*	97
PC	0	0	64	2,300	NB*	120
	0	3	64	2,300	NB*	114
ASA	0	0	44	2,100	22	-
	3	0	40	2,000	23	-
	0	3	41	2,000	21	-
PMMA	0	0	75	3,100	1	83
	3	0	76	2,900	1	79
	5	0	71	2,900	1	78

* NB = Not break

Table 9 Mechanical properties of TPO and crosslinked EPDM added NOF®-ALLOY KA832

Resin	KA832	Tensile		Hardness	Compression set	
		Strength	Elongation	Shore A	23 ℃	120 ℃
	phr	MPa	%	-	%	%
TPO	0	10	590	A 87	26	91
	2	10	630	A 86	30	81
	5	11	630	A 84	27	101
Cross-linked EPDM	0	16	180	A 65	5	6
	2	16	220	A 64	7	6
	5	15	220	A 64	8	8

9 Package

- **20kg in paper bag**

10 Notes

- If the NOF®-ALLOY KA series are spilled on the floor, it will be very slippery so please collect immediately and remove it.
- Please note that NOF®-ALLOY KA147 is a powder form and there is a possibility of dust explosion.
- Although the content described in this document is based on materials, information, data etc. that were available at the present time, it is not a guarantee concerning physical properties, chemical properties, hazards etc.
- When using this product, please test and check the legal regulations corresponding to the application and conformity / safety to use.
- For other general matters, please refer to the safety data sheet (SDS).

■ Handling of contents of description

Although the contents of the description are prepared based on the materials, information and data that were available at the moment, we do not make any guarantee as to the written data, evaluation, danger, etc. In addition, since the items described are intended for normal handling, please adequate safety measures for the specific usage are required when handling in special ways.

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