

Polybutylene Terephthalate (PBT)

DURANEX®

315NF

EF2001/ED3002

Halogen-free, Higher
Comparative Tracking
Index

POLYPLASTICS CO., LTD.

Introduction

The **DURANEX® PBT NF Series** is comprised of self-extinguishing grades that we have developed, which contain non-halogenated flame retardants, in order to meet environmental regulations in countries around the world. UL94 V-0 flame retardance is exhibited without the use of halogenated flame retardants or antimony compounds.

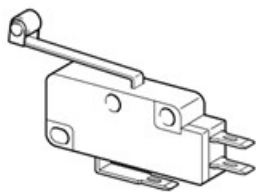
In addition, with significant improvement on flame retardants, the **DURANEX NF Series** exhibits higher electrical and light resistance than our conventional halogenated/non-halogenated self-extinguishing grades. Specifically, they have the following properties:

DURANEX® PBT NF Series properties

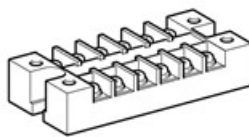
1. Tracking resistance: PLC \geq 1 (CTI: 400 V or more, all grades)
2. Non-bleeding type: non-halogenated flame retardant
3. Highest level weather/light resistance (susceptibility to discoloration) among flame-retardant grades
4. Flame retardants utilized that comply with international environmental labels WEEE/RoHS

Small quantities of fluoro-resin are used in this material.

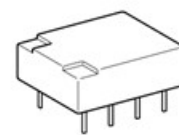
< Applications >



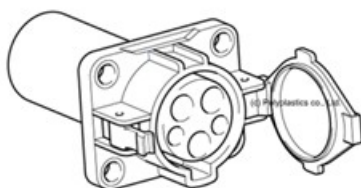
Switches



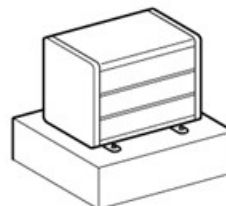
Terminal blocks



Relays



Charging inlets



Storage batteries

1. General Properties of NF Series

Table 1-1 General properties of NF Series (ISO)

| Item | Unit | Test method | 201NF non- reinforced Standard | 310NF GF10% reinforced Standard | 315NF GF15% reinforced Standard | 315NFK GF15% reinforced CTI/PLC:0 | 320NF GF20% reinforced Standard | 330NF GF30% reinforced Standard |
|---|-------------------|----------------|---|--|--|--|--|--|
| Water absorption (24h. immersion) | % | ISO 62 | 0.2 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 |
| Density | g/cm ³ | ISO 1183 | 1.32 | 1.40 | 1.45 | 1.45 | 1.49 | 1.57 |
| Tensile strength | MPa | ISO 527-1,2 | 50 | 70 | 80 | 80 | 90 | 100 |
| Strain at break | % | ISO 527-1,2 | 10 | 3.5 | 2.8 | 2.8 | 2.3 | 1.7 |
| Flexural strength | MPa | ISO 178 | 80 | 120 | 130 | 130 | 140 | 147 |
| Flexural modulus | MPa | ISO 178 | 2,800 | 5,000 | 6,400 | 6,400 | 7,600 | 10,100 |
| Charpy notched impact strength | kJ/m ² | ISO 179/1eA | 3 | 4 | 5 | 5 | 5 | 7 |
| Temperature of deflection under load (1.8MPa) | °C | ISO 75-1,2 | 80 | 200 | 207 | 207 | 210 | 214 |
| Flammability | | UL94 | V-0* | V-0* | V-0* | V-0* | V-0* | V-0* |
| Dielectric breakdown strength (3mmt) | kV/mm | IEC 60243-1 | 18 | 19 | 19 | 19 | 20 | 22 |
| Volume resistivity | Ω·cm | IEC 60093 | 6E+16 | — | — | — | — | 3E+16 |
| Surface resistivity | Ω | IEC 60093 | 1E+17 | — | — | — | — | 4E+16 |
| Comparative tracking index | CTI | IEC 60112 | 600* | 550* | 550* | 600* | 500* | 600* |
| Arc resistance | s | ASTM D495 | 125* | 124* | 99* | 99* | 125* | 128* |
| GWFI | °C | IEC 60695-2-12 | 960 | 960 | 960 | 960 | 960 | 960 |

The above values are representative values obtained by injection molding. They are not minimum values of the material specifications.
The data shown here cannot necessarily be applied "as is" to parts that are utilized under different conditions.
Natural products are used for each evaluation.

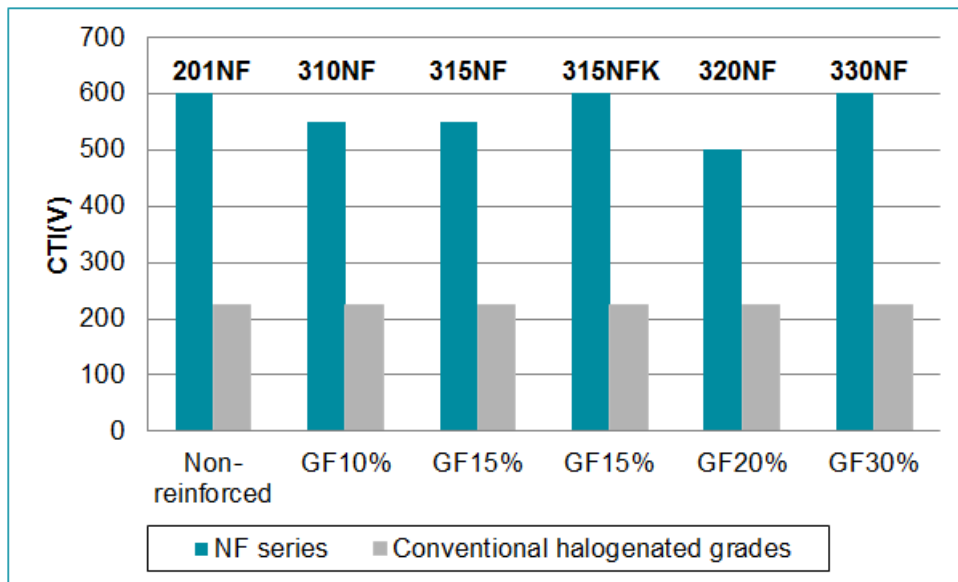
* Refer to "2. NF Series Electrical Safety (UL Certification Values)" regarding UL (Underwriters Laboratories Inc.).

All grades are subject to Japan's Ministerial Ordinance for Export Trade Control.

2. NF Series Electrical Safety (UL Certification Values)

2.1 Tracking resistance

The **NF Series** shows excellent tracking resistance as compared with conventional halogenated flame retardant grades. In particular, **201NF**, **315NFK** and **330NF** have been UL certified with the highest PLC Rank of 0.



**Fig. 2-1 Tracking resistance of NF series
(comparison with conventional halogenated grades)**

< What is the tracking phenomenon? >

Tracking is the phenomenon of dielectric breakdown that occurs on insulating surfaces caused by moisture or contamination.

When voltage is applied to moist or contaminated insulating surfaces (A), partial evaporation and drying occurs (B).

Voltage is then concentrated in a part of the insulator surface, discharging a minute light emission called scintillation, resulting in some degradation and carbonization of part of the insulator surface due to heat discharge (C).

Carbides then facilitate the flow of electrical discharge, creating a conductive leakage path across the surface of the material by forming a carbonized track. Eventually, short-circuiting occurs between conductors causing combustion (D). This electrical breakdown phenomenon is called tracking.

Using UL's Comparative Tracking Index (CTI), tracking resistance is classified into six ranks (*) according to breakdown voltage.

*CTI PLC (Performance Level Category)

600V ≤ Rank 0

400V ≤ Rank 1 < 600V

250V ≤ Rank 2 < 400V

175V ≤ Rank 3 < 250V

100V ≤ Rank 4 < 175V

Rank 5 < 100V

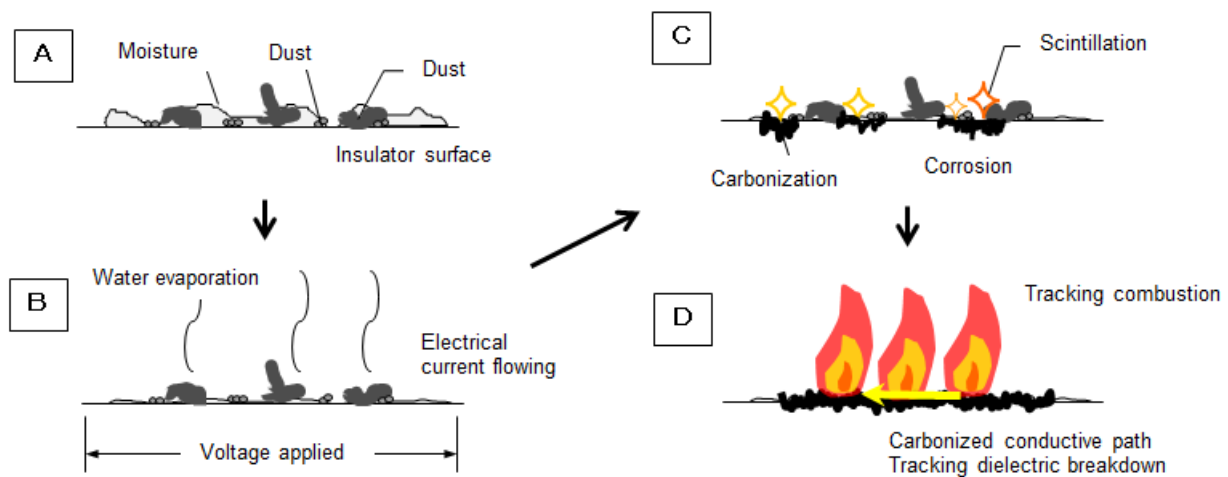


Fig. 2-2 Deterioration by tracking

2.2 UL certification values

Table 2-1 UL certification values of NF series

| GF(%) | Grade | Flamability (UL94) | CTI (746A) | HAI (746A) | HWI (746A) | RTI (0.75mm) (746B) | | | UV&Water (0.75mm) (746C) |
|----------------|--------|---|---------------|---------------|----------------------|---------------------|-------|-----|--------------------------------|
| | | | | | | Elec. | Mech. | | |
| | | | | | | | Imp | Str | |
| Non-reinforced | 201NF | V-0 0.75mm | 0 | 0 | 3 (2 for ≤ 1.5mm) | 125 | 110 | 125 | – |
| 10 | 310NF | V-0 0.75mm | 1 | 0 | 1 | 130 | 125 | 125 | f1 (B) |
| 15 | 315NF | V-0 0.75mm | 1 | 0 | 2 (0 for 3.0mm) | 130 | 120 | 120 | f1 (B) |
| 15 | 315NFK | V-0 0.4mm | 0 | 0 | 2 (0 for 3.0mm) | 130 | 120 | 120 | f1 (B) |
| 20 | 320NF | V-0 0.75mm (All) V-0 0.4mm (N&B) | 1 | 0 | 1 | 125 | 125 | 125 | f1 (B) |
| 30 | 330NF | V-0 0.4mm | 0 | 0 | 1 | 125 | 140 | 140 | f1 (All) |

UL registered color are in parentheses. All: All Color, N: Natural, B: Black

Note: For details, please refer to the Yellow Card published by UL (File No. E213445).

3. NF Series Weather/Light Resistance (Susceptibility to Discoloration)

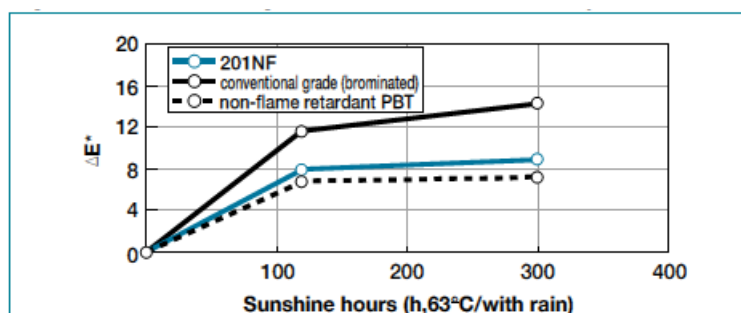
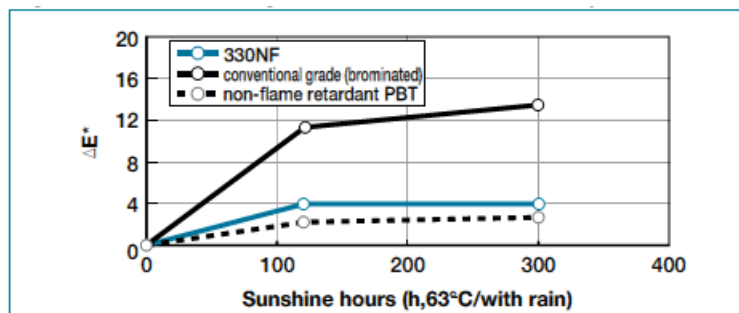


Fig. 3-1 Weather/Light resistance of non-reinforced materials

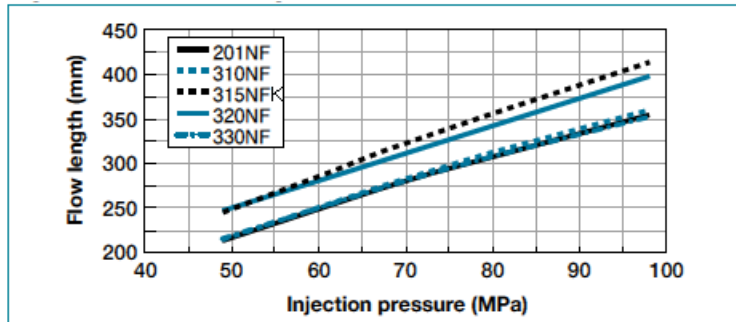


Test instrument : sunshine weatherometer
 Black panel temperature : 63°C
 Falling rain : yes
 * Evaluated with natural color
 (color number: EF2001)

Fig. 3-2 Weather/Light resistance of GF30% materials

4. NF Series Moldability

4.1 Flowability



■ Molding parameters

Molding machine : Nissei ES3000
 Cylinder temperature : 260-260-260-260-230°C
 Mold temperature : 60°C
 Injection speed : 4m/min.
 Mold : Bar flow test Mold

Fig. 4-1 Bar flow length (2mmt)

4.2 Mold shrinkage

Table 4-1 Flat plate mold shrinkage (120□×2mmt)

| | Direction | Non-reinforced | GF10% | GF15% | GF20% | GF30% |
|------------------------|----------------------|----------------|-------|--------|-------|-------|
| | | 201NF | 310NF | 315NFK | 320NF | 330NF |
| Holding pressure 59MPa | Flow direction | 2.0 | 1.1 | 0.7 | 0.6 | 0.4 |
| | Transverse direction | 2.0 | 1.5 | 1.5 | 1.4 | 1.4 |
| | Average | 2.0 | 1.3 | 1.1 | 1.0 | 0.9 |
| Holding pressure 69MPa | Flow direction | 1.9 | 1.0 | 0.7 | 0.5 | 0.4 |
| | Transverse direction | 1.8 | 1.3 | 1.3 | 1.3 | 1.2 |
| | Average | 1.8 | 1.1 | 1.0 | 0.9 | 0.8 |

■ Molding parameters

Molding machine : Nissei ES3000
 Cylinder temperature : 260-260-260-260-230°C
 Mold temperature : 60°C
 Injection speed : 1m/min.
 Mold : 120□×2mm flat plate (side gate: 4w x 2t)

< Notes for molding **DURANEX® PBT** >

●Predry under the following conditions:

Predrying Temperature 120°C/Predrying Time 5hrs. Predrying Temperature 140°C/Predrying Time 3hrs.

Make sure that the pellet temperature reaches the required level, not the preset temperature of dryer.

To keep the material dry, use of hopper dryer is recommended (95 - 105°C).

●To prevent decomposition of material, follow the recommended conditions below:

1) Optimum material temperature: 240 - 260°C Do not heat above 280°C

2) Maximum residence time in cylinder: Cylinder Temperature/Maximum Residence Time

Slow Burning Type 260°C/30min, Flame Retardant Type 260°C/10min

(The above conditions are typical upper limits and may vary under different conditions.)

(The above molding conditions must be used at all times because acids are generated if the material is exposed to high temperatures (280°C or higher) for a prolonged period.)

●In case the decomposition of the material is seen or suspected, lower the cylinder temperature and purge (discharge) the material from the cylinder.

During purging, wear safety goggles and keep hands and face away from the nozzle section.

●When shutting down the molding operation, purge DURANEX and turn the heater off.

●Do not mix any colorants, additives or resins of other brands with **DURANEX** except those we recommend.

●For replacing **DURANEX** with another material, **DURANEX** should be purged by polyethylene (PE) or polystyrene (PS).

●Keep the work place ventilated locally or entirely during operation.

5. Long-term Stability of Electrical Property

5.1 Comparison of long-term heat stability of insulation resistance

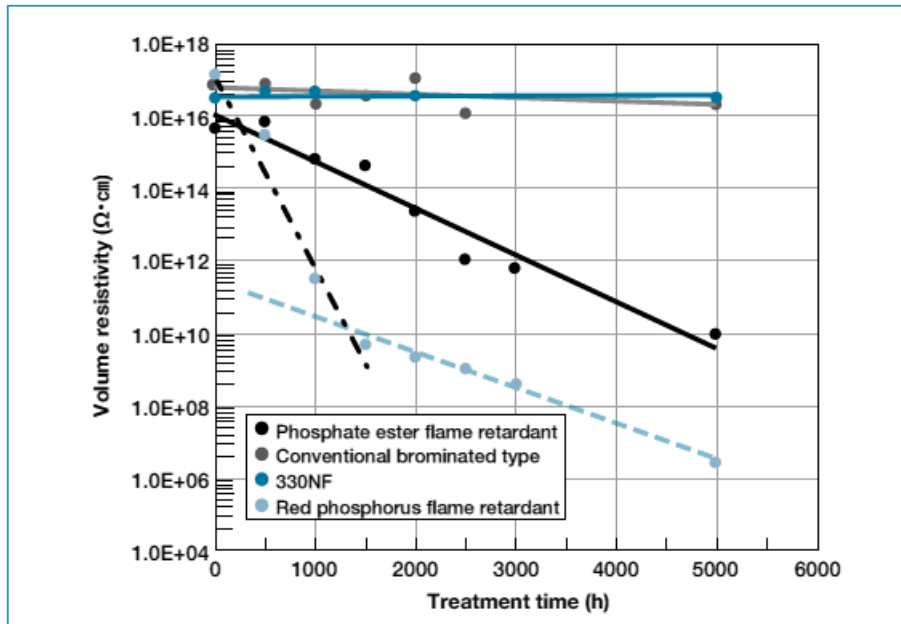


Fig. 5-1 Changes in volume resistivities of molded products heated for extended periods (150°C)

5.2 Comparison of amounts of phosphorus-based soluble decomposition products

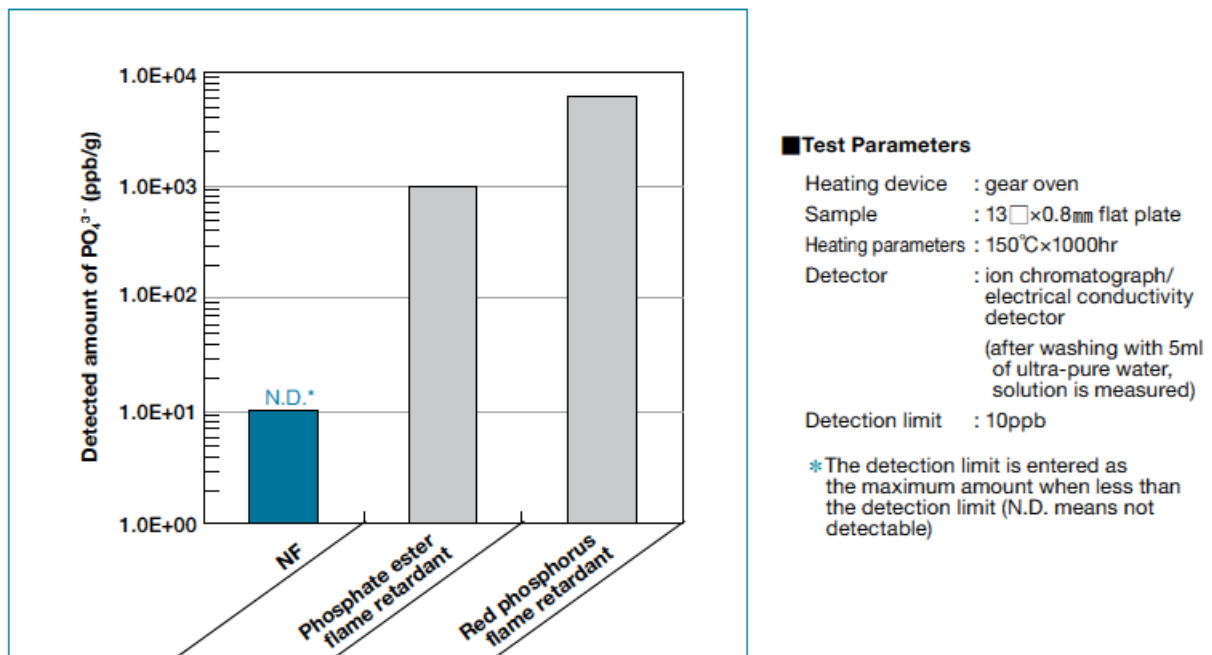


Fig. 5-2 Phosphoric acid surface precipitation amount during heating of molded products (1000hrs)



NOTES TO USERS

- All property values shown in this brochure are the typical values obtained under conditions prescribed by applicable standards and test methods.
- This brochure has been prepared based on our own experiences and laboratory test data, and therefore all data shown here are not always applicable to parts used under different conditions. We do not guarantee that these data are directly applicable to the application conditions of users and we ask each user to make his own decision on the application.
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- For safe handling of materials we supply, it is advised to refer to the Safety Data Sheet "SDS" of the proper material.
- This brochure is edited based on reference literature, information and data available to us at the time of creation. The contents of this brochure are subject to change without notice upon achievement of new data.
- Please contact our office for any questions about products we supply, descriptive literatures or any description in this brochure.

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(R240110-1359)