NICHIAS Technical Report
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〈Product Introductions〉

PTFE・PFA・PCTFE/ Sheets, tapes, rods, pipes
"Naflon® materials"

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1. Introduction

NICHIAS generically brands our products made from fluorocarbon resins which have superior features Naflon® products. Since 1951 when we started studying fluorocarbon resin processed products, we have been developing various products which take advantage of the superior features of fluorocarbon resins. During this period, we have accumulated unique forming and processing technology.

In this report, we introduce types and features of "Naflon® materials" (**Figure 1**) which are used for machining and punching.

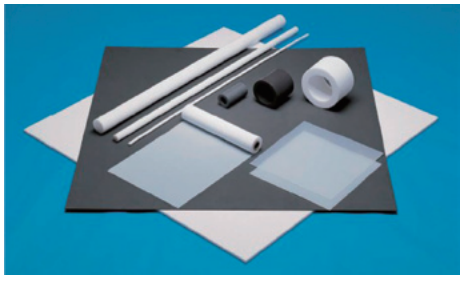


Figure 1. "Naflon® materials"

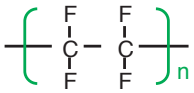
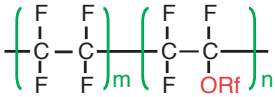
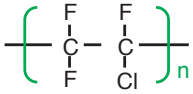
2. Fluorocarbon resins

Fluorocarbon resin is a synthetic resin which has excellent heat resistivity, chemical resistivity electrical insulation, non-stick, and weather resistivity all together, and it is used in a wide variety of fields from chemical industry, semiconductors, and automotive industry to household appliances such as the coating on non-stick frying pans.

2.1 Types of fluorocarbon resin

Mainly, 8 types of fluorocarbon resin[1] are known. Among them, polytetrafluoro-ethylene (PTEE) and tetrafluoroehtylene-perfluoroalkylvinylether copolymer (PFA) are commonly used for industrial application. In addition, polychlorotrifluoroethylene (PCTFE) is also used taking advantage of its excellent gas barrier and mechanical properties (**Table 1**).

Table 1. Structure and features of major fluorocarbon resins

Name	Structural formula	Features
PTFE		Excellent heat resistivity, chemical resistivity, electrical resistivity, non-sticking property, and self-lubricity.
PFA		Similar features to those of PTFE and in addition, complicated shapes can be formed by melt molding.
PCTFE		Excellent mechanical properties. Gas permeation is low.

2.2 Features of fluorocarbon resins

Fluorocarbon resin has excellent features as shown below[2].

(1) Heat resistivity

Maximum continuous service temperature for PTFE and PFA is 260℃.

(2) Chemical resistivity

Practically, it is inert to almost all industrial chemicals except some compounds (CIF_3, OF_2) that generate active fluorine gas at high temperatures, high temperature fluorine gas and melting alkaline metals.

(3) Electrical insulation

Fluorocarbon resin has the lowest dielectric constant among plastics, and is used as a very excellent electrical insulation material.

(4) Non-stick property

Fluorocarbon resin has a peculiar property in that it is difficult for other materials to stick to it due to its low surface energy. It is difficult even for tacky materials to stick to it, and its mold releasing feature is also good.

(5) Low friction feature

It shows the lowest friction coefficient among all solid substance and has self-lubricity.

(6) Weather resistance

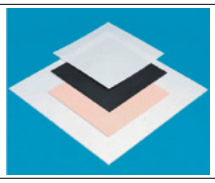
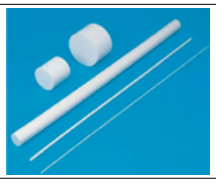
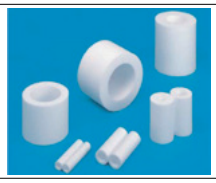
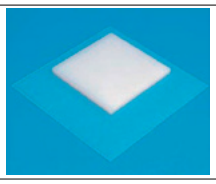
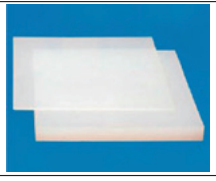
It has superior weather resistance and degradation is not observed even when used outdoors for a long time.

3. "Naflon® material"

3.1 Overview

"Naflon® material" is a product formed as sheet, tape, rod or pipe made from PTFE, PFA or PCTFE as the primary material. **Table 2**

Table 2. List and application examples of major "Naflon® materials"

Primary material	Shape	Sheet	Tape	Rod	Pipe
PTFE	Product name	TOMBO™ No.9000 "Naflon® PTFE sheet"	TOMBO™ No.9001 "Naflon® PTFE tape"	TOMBO™ No.9002 "Naflon® PTFE rod"	TOMBO™ No.9008 "Naflon® PTFE pipe"
	Photograph				
	Application example	Material of gaskets Pump and valve parts	Releasing material for producing electronic parts Insulation film	Connectors Stopcocks for laboratory instruments	Ball sheet Backup ring O-ring
PFA	Product name	TOMBO™ No.9000-PFA "Naflon® PFA sheet"		TOMBO™ No.9002-PFA "Naflon® PFA rod"	
	Photograph				
	Application example	Material for gaskets		Welding parts	
PCTFE	Product name	TOMBO™ No.9000-PCTFE "Naflon® PCTFE sheet"		TMOBO™ No.9002-PCTFE "Naflon® PCTFE rod	
	Photograph				
	Application example	Semi-conductor parts transporting jig		High pressure valve	

shows a list of "Naflon® materials" and examples of their application.

These materials are processed in to various shapes and used depending on the customer's reguirement For example, sheet product is punched and used as gaskets (**Figure 2**), and taking advantage of PTFE's chemical and heat resistivity, it prevents leakage of chemical liquid flowing in piping. Rod product can be processed to make various shapes by machining such as lathe turning (**Figure 3**).

By blending the fluorocarbon resins with inorganic fillers such as glass fiber or graphite. For example, when using pipe for bearing material, because simple substance of PTFE is soft and tends to creep, it has a tendency to cause deformation failure for application of heavy load bearings. For such application, we can modify the material to improve creep resistivity by blending carbon fiber as the filler material. **Table 3** shows types and features of major filler materials added for "Naflon® materials".

Table 3. Types and features of major filler materials[3)]

Type of filler materials	Features
Glass fiber	・To improve mechanical properties and abrasion resistance significantly ・Having demerit to wear the other material.
Graphite	・To improve cold flow* resistance ・Having good thermal conductivity, and superior chemical resistivity
Bronze	・To improve abrasion resistance, hardness, compressive strength, and thermal conductivity ・Poor chemical resistance due to metallic substance
Carbon fiber	・To improve compressive strength and abrasion resistance ・Having superior creep property in high temperature area, and good abrasion resistance in the water.

*Cold flow: Phenomenon that the material deforms over time when load is applied continuously.

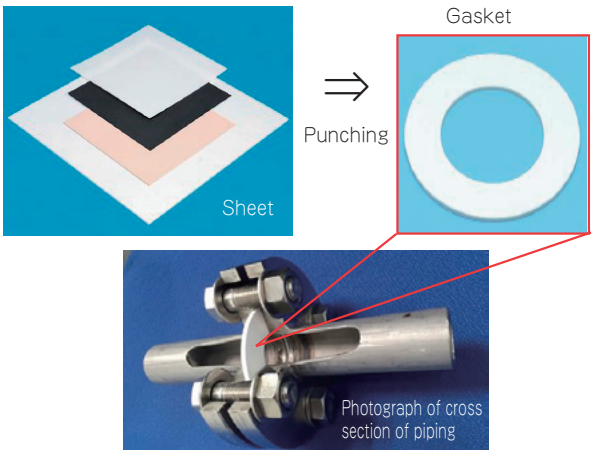


Figure 2. Example of a product made of sheet

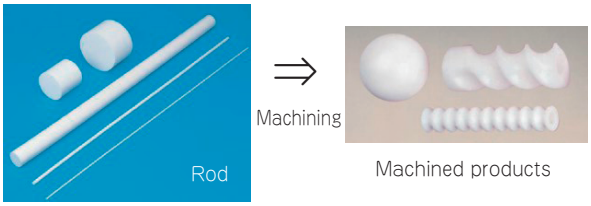


Figure 3. Example of products machined from rod

3.2 Various "Naflon® materials"

3.2.1 Sheet

・TOMBO™ No.9000 "Naflon® PTFE sheet"
・TOMBO™ No.9000-PFA "Naflon® PFA sheet"
・TOMBO™ No.9000-PCTFE "Naflon® PCTFE sheet"

Sheets are formed by compression molding, and three materials are available namely PTFE, PFA, and PCTFE. They are punched and used for gaskets as mentioned above, or taking advantage of PCTFE's mechanical properties, used for materials of semi-conductor silicon wafer transporting jigs.

3.2.2 Tapes

・TOMBO™ No.9001 "Naflon® PTFE tape"

Tapes are manufactured by machining cylindrical PTFE material to make film (**Figure 4**). They are used for insulation film or releasing material for producing electronic parts. We also have TOMBO™ No.9004 "Naflon® PTFE cementable tape", with surface treatment, allowing it to be bonded by adhesive.

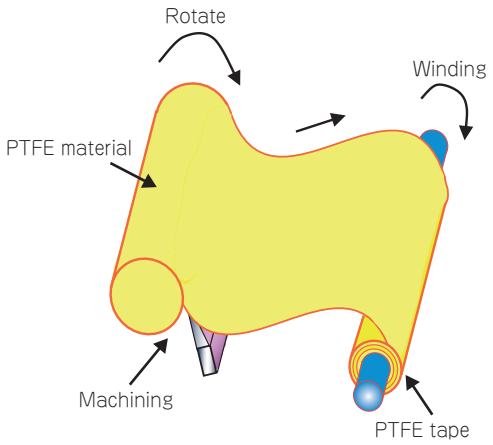


Figure 4. Making PTFE tape by machining

3.2.3 Rods

・TOMBO™ No.9002 "Naflon® PTFE rod"
・TOMBO™ No.9002-PFA "Naflon® PFA rod"
・TOMBO™ No.9002-PCTFE "Naflon® PCTFE rod"

Three materials are available as those made of PTFE, PFA, and PCTFE. Among them, PFA rod has heat-melting properties and is therefore used as consumables for welding fluorocarbon resins each other. On the other hand, PCTFE rod has good features of compressive strength and gas barrier properties, and is used for high pressure valve sheets.

3.2.4 Pipes

・TOMBO™ No.9008 "Naflon® PTFE pipe"

Pipes are cylindrical thick pipe materials formed by compression molding. Taking advantage of low friction property that is unique to PTFE, they are used for bearings, used for materials for machining to make ring shape parts.

4. Advantage of "Naflon® materials"

Since we manufacture "Naflon® materials" in our own factory with various manufacturing processes, we can supply the materials with a wide range of dimensions as shown in **Table 4**.

In addition to the standard shapes introduced here, we can supply materials already formed to the shape of final products, which will contribute to reduction in your processing hours and is also a move efficient use of material.

For example, because it is difficult to manufacture the walled hollow parts with thin wall or deformed shape by compression molding, they are usually manufactured by machining of a thick material. We can however manufacture hollow materials similar to the shape of desired products using special molding method called Poisson molding there by reducing machining time, significantly reducing waste, and reducing in much manufacturing cost (**Figure 5**).

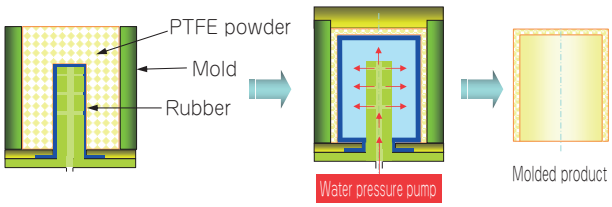


Figure 5. Outline of Poisson molding method

Table 4. Available dimensions of Naflon® materials* (mm)

Primary material	Sheet	Tape	Rod	Pipe
PTFE	Thickness : 1～75 Width : 300～1220 Length : 300～1220	Thickness : 0.05～2 Width : 300～500 Length : 10MT～100MT	Outer diameter : 1～220 Length : 100～1000	Outer diameter : 20～1115 Length : 100～1000
PFA	Thickness : 3～40 Width : 200～500 Length : 200～500	–	Outer diameter : 1～100 Length : 300～1000	–
PCTFE	Thickness : 3～40 Width : 200～500 Length : 200～500	–	Outer diameter : 25～50 Length : 300	–

*The producible combination of dimensions depends on the thickness, outer diameter, and type of filler material. Please inquire us for the detail.

5. Conclusion

"Naflon® materials" introduced here are packings, electrical insulation materials, thermal insulation materials, bearings, or washers and are used everywhere in our lives taking advantage of the excellent features we will continue to develop new technology as well as improve the existing product to meet customer's needs and make Naflon more user-friendly product. For any inquiry regarding this product, please contact Piping/Equipment Parts Technology Development Department, Industrial Product Division.

References

1) Fluorocarbon resin handbook , Edited by Takaomi Satokawa, Nikkan Kogyo Shimbun Ltd. P.142 (1990)
2) Fluorocarbon resin Dupont™ Teflon® Practical Handbook, Edited by Mitsui-Dupont Fluorochemical Co.Ltd., Mitsui-Dupont Fluorochemical Co.Ltd., P6 (1990)
3) Fluorocarbon resin handbook, edited by 13th edition editional board, Japan Fluoropolymers Industry Association, P52 (2014)