

Application number: E.2.10 (Transport)

Application name: Auxiliary material (mold release) for manufacturing aircraft parts

An exemption is requested for the following application of PFAS used in the aviation field.

Product: Fluororesin film for aviation field

Fluororesin used: PTFE (CAS No. 9002-84-0)

Product overview: Release film (auxiliary material for molding aircraft parts such as CFRP stringer)

Product requirements: Heat resistance, releasability, etc.

Alternative: None

As a release film, it satisfies many of the required functions such as releasability from a prepreg, and there is no alternative at present because of the quality risks associated with other polymeric materials.

Typical properties of PTFE are shown below.

Table 1.1.10 Wettability¹⁾

Type of material	Contact angle of water (degrees)	Adhesion energy with water ($\times 10^{-3}$ N/cm)	Critical surface tension (γ_c) ($\times 10^{-3}$ N/cm)
FEP	115	42.0	16.2
PTFE	114	43.1	18.5
PFA	(Same level as those of FEP or PTFE)		
Silicone resin	90~110	47.8~72.7	—
Paraffin	10.5~10.6	52.7~53.8	23
Polyethylene	88	75.2	31
Nylon	77	97.7	46
Phenol	60	109	—

Physical properties	Test method	Unit	PPS	PAR	PTFE	PSU	PES	Physical properties	Test method	Unit	LCP	PEEK	PEI	PAI	TPI			
Classification and features			GF30% cross-linking type	Natural	Natural	Natural	GF30% Natural	GF30% Natural	Classification and features		GF30% type I	GF30% type II	GF30% type III	Natural	GF30% high flow	Natural	Natural	Anomalous, natural
Mechanical properties									Mechanical properties									
Tensile strength	ASTM D 638	MPa	150	70	27~34	71	108	84	140	MPa	137	211	113	97	236	105	191	92
Tensile elongation at break	ASTM D 638	%	1.2	70	200~400	50~100	2	80	3	%	1.7	2.2	3.8	80	5	60	15	90
Bending strength	ASTM D 790	MPa	206	78	118 ⁽³⁾	108	157	129	190	MPa	157	250	176	142	330	145	240	137
Bending modulus of elasticity	ASTM D 790	GPa	13.7	1.9	0.34~0.62	2.6	7.6	2.5	8.3	GPa	13.3	14.7	12.6	3.7	21.1	3.3	5.0	2.9
Load impact strength: Notched	ASTM D 256	J/m	69	245	157	69	78	88	78	J/m	108	137	118	88	—	49	147	88
Rockwell hardness	ASTM D 785	R-scale	123	125	—	120	134	120	134	R-scale	77	84(M)	69	126	124	109(M)	86(E)	129
Thermal properties									Thermal properties									
Load deflection temperature ¹⁾ : 0.45 MPa load	ASTM D 648	°C	260	175	55	—	—	203	216	°C	346	240	180	152	300	200	278	238
: 1.82 MPa load		°C	—	—	121	174	181	210	—	°C	—	—	—	—	—	210	—	—
Continuous use temperature ²⁾	UL746B	°C	200~220	140~160	180	140~160	140~160	180~190	180~190	°C	240~280	~220	—	240	240	170~180	200~220	—
Linear expansion coefficient	ASTM D 696	10 ⁻⁵ /°K-1	2.9	6.2	10	5.6	1.9	5.6	2.3	10 ⁻⁵ /°K-1	1.2	—	—	4.6	—	5.6	3.1	5.5
Combustibility			—	V-0/V5	V-2	V-0	HB	V-0	V-0	V-0	—	V-0	V-0	V-0	V-0	V-0/V5	V-0	V-0
Physical properties									Physical properties									
Specific gravity	ASTM D 792	—	1.67	1.21	2.14~2.20	1.24	1.49	1.37	1.60	—	1.60	1.62	1.60	1.30	1.44	1.27	1.42	1.33
Water absorption rate	ASTM D 570	%	0.05	0.26	<0.01	0.3	0.49	0.43	0.30	%	<0.1	0.05	0.02	0.14	—	0.25	0.33	0.34
Mold shrinkage rate	ASTM D 955	mm/mm	0.0025	0.008	—	0.007	0.002	0.006	0.002	mm/mm	—	—	0.0027 ⁽¹⁾	—	0.006	0.006	—	0.008
Electrical properties									Electrical properties									
Volume resistivity	ASTM D 257	Ω·mm	1×10 ¹⁵	2×10 ¹⁶	>10 ¹⁷	—	10 ¹⁵	10 ¹⁵	—	Ω·mm	1×10 ¹⁵	3×10 ¹⁵	5×10 ¹⁵	10 ¹⁶	—	10 ¹⁶	2×10 ¹⁶	—
Dielectric fracture strength	ASTM D 149	kV/mm	17.2	—	30~35	17	19	16	16	kV/mm	25	43	—	19	—	30	24	—
Dielectric constant (10 ⁵ Hz)	ASTM D 150	—	3.8	3.0	<2.1	3.1	3.7	3.5	—	—	3.6	3.8	2.7	3.3	—	3.15	3.9	3.1
Dielectric loss tangent (10 ⁵ Hz)	ASTM D 150	—	0.0014	0.01	0.0001	0.005	0.004	0.0035	—	—	0.034	0.017	0.030	0.003	—	0.0013	0.031	0.0034

Notes (1) Previous "thermal deformation temperature"

(2) There are three items: mechanical strength (with or without impact); and electrical properties.

(3) Compressive strength

(4) Average value of MD and TD. Actual value: MD/TD=0.0013/0.0033

Remarks Abbreviations and names of the resins are as follows.

PPS: polyphenylene sulfide, PAR: polyarylate, PTFE: polytetrafluoroethylene,

PSU: polysulfone, PES: polyethersulfone, LCP: liquid crystal polymer,

PEEK: polyether ether ketone, PEI: polyetherimide, PAI: polyamideimide,

TPI: thermoplastic polyimide, GF: glass fiber

Cited literature

1) Dupont-Mitsui Fluorochemicals Co., Ltd., "Teflon Practical Handbook", 1989

2) "Fluororesin Handbook" edited by Takaomi Satokawa, Nikkan Kogyo Shimbu, Ltd., 1990

3) Industrial Material, November, 1976, Nikkan Kogyo Shimbu, Ltd.

4) Takaharu Ikeda, Valqua Review, Vol. 35, No. 1

5) "Plastic Processing Technology Handbook" edited by The Society of Polymer Science, Japan, Nikkan Kogyo Shimbu, 1995

6) Daikin Industries, Ltd., Technical Materials

7) Dupont-Mitsui Fluorochemicals Co., Ltd., Technical Materials

Reference material: VALQUA Handbook Technical Section

Socio-economic impacts/concerns:

In the aviation field, weight reduction has been in progress and the application of CFRP is expanding year by year.

In cases where it became impossible to use a fluororesin film used in CFRP processing, socio-economic impacts on the aviation field would be significant.

Based on the above, we propose a permanent exemption.