

DAIKIN

EG-37

Adhesive fluoropolymer
NEOFLON™
EFEP



Creating New Possibilities for
Fluoropolymers

DAIKIN INDUSTRIES, LTD.

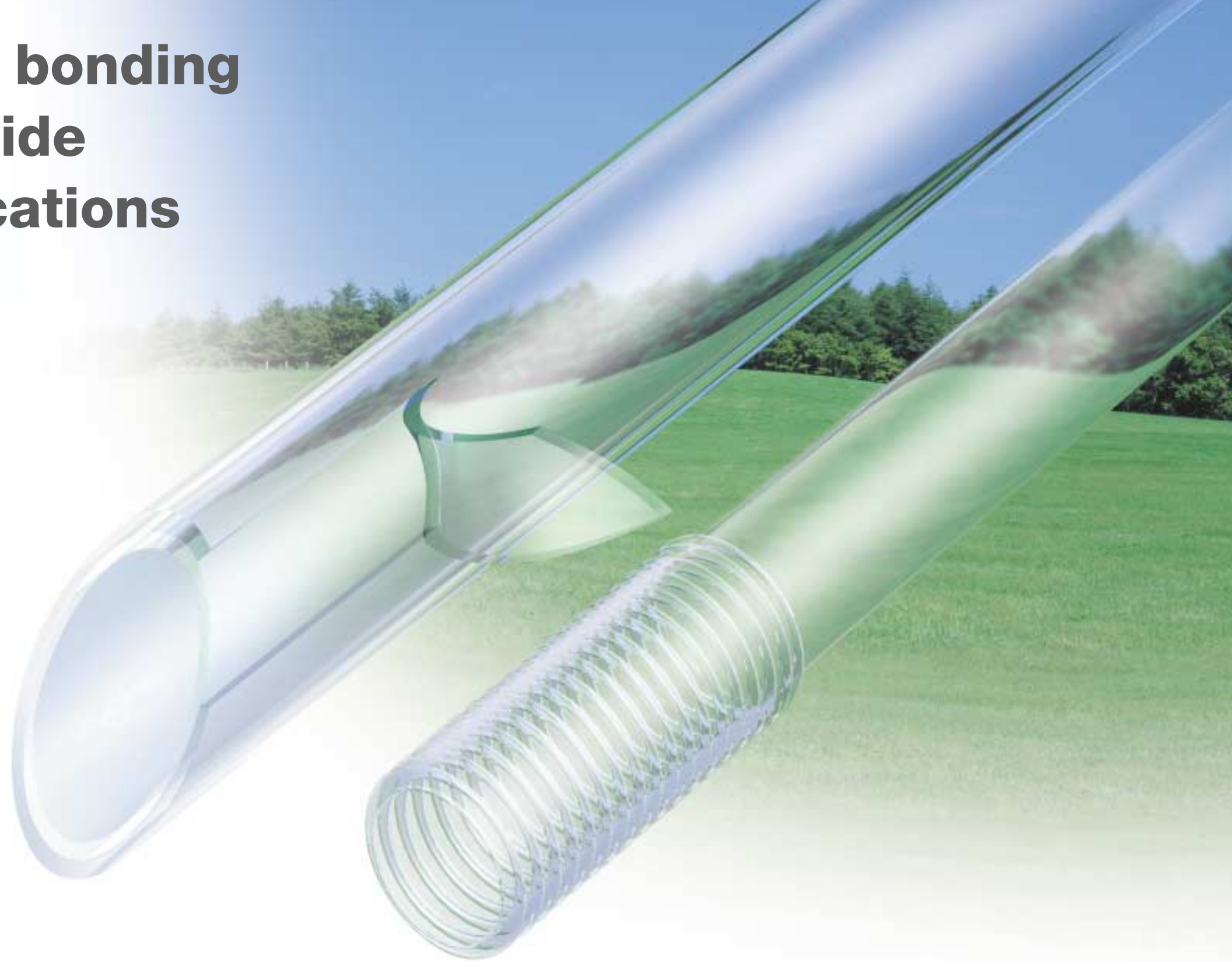
Fluoropolymers with bonding properties serve a wide variety of new applications

NEOFLON™ EFEP

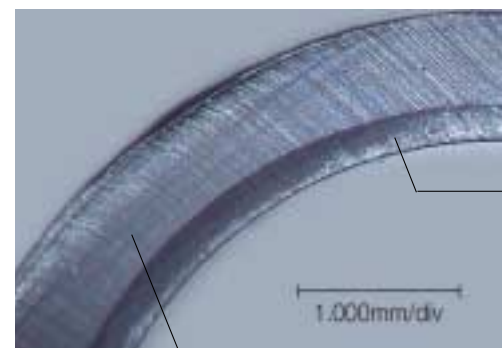
The world's first* fluoropolymer that can directly bond to other materials
Opening new horizons for fluoropolymers

Fluoropolymers are used in a variety of applications because of their excellent chemical resistance, non-stick properties, electrical insulation properties and weathering resistance. However, fluoropolymers do not bond well to other materials due to their strong non-stick properties and their workability is relatively poor despite their superior heat resistance. NEOFLON EFEP is the world's first-ever material that features a revolutionary combination of standard fluoropolymer properties and strong bonding capabilities. With its moldability, workability and transparency also being improved, NEOFLON EFEP is the next-generation materials that will expand further the range of possibilities for fluoropolymers.

*As of May 1, 2003, according to DAIKIN's research.



An Example of direct bonding



EFEP(RP-5000) 250μm

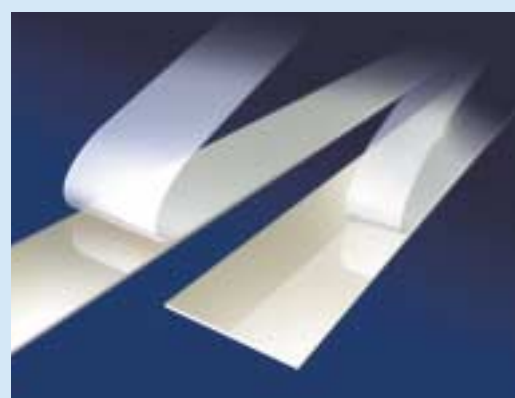
PA12 750μm

Photograph showing a cross-section of an automobile multi-layer fuel tube

NEOFLON™ EFEP

Excellent bonding properties and workability. Enhanced transparency, too. NEO FLON™ EFEP will expand further the range of possibilities for fluoro polymers.

Enhanced Bonding Properties



Non-stick properties and bonding properties— these two conflicting properties meet together in harmony, realizing direct bonding to other materials.

Reactive groups have been introduced so that the bonding properties manifest themselves above the melting temperature. This makes the fluoropolymer capable of easily bonding to other materials such as engineering plastic and metal while maintaining their non-stick properties, the attractive features of fluoropolymers, at room temperature, thereby expanding the horizons of applications as a composite material.

Effects of Reactive Groups

Morphology after blending EFEP/Adhesive/PA12.
Blend conditions: 260°C × 8min (lab mil)



(a) PA12/EFEP blend without reactive groups

(b) PA12/EFEP blend with reactive group

Bonding to Other Materials

EFEP/Adhesive/ Other material (thickness in μm)	Bonding condition		Peel strength
	Method	Condition	
Nylon 6 (250/750)	Co-extrusion	EFEP : 240 °C Nylon : 250 °C, Die : 260 °C	>40 N/cm
Nylon 12 (250/750)	Co-extrusion	EFEP : 260 °C Nylon : 240 °C, Die : 260 °C	>40 N/cm
Nylon elastomer (500/500)	Co-extrusion	EFEP : 260 °C Nylon elastomer : 270 °C, Die : 240 °C	30 N/cm
EVOH (250/750)	Co-extrusion	EFEP : 260 °C EVOH : 220 °C, Die : 240 °C	>30 N/cm
Aluminum (200/500)	Lamination	Heat-roll : 180 °C	>30N/cm (film break)
SUS430-caustic cleanser (200/500)	Lamination	Heat-roll : 205 °C	>30N/cm (film break)

Low Temperature Molding



Molding at low temperatures is possible. Improved productivity and reduced costs. (RP-4020)

With its melting point around 160°C (compared to a 265°C for standard ETFE), NEOFLON EFEP RP-4020 can be processed at lower temperatures. This allows simultaneous processing (e.g., co-extrusion) with nylons and other plastic engineering materials, increasing productivity and lowering costs.

	RP-4020	RP-5000	PFA	ETFE
Melting point (°C)	160	195	305	265
Molding temperature (°C)	200~240	220~260	350~400	290~320
Die temperature (°C)	30~80	30~100	180~220	130~150

Examples of Injection Molding Conditions

	Unit	RP-4020	RP-5000
Cylinder temperature			
Rear	(°C)	180 – 200	200 – 220
Middle	(°C)	200 – 220	220 – 240
Front	(°C)	230 – 250	250 – 270
Nozzle	(°C)	230 – 250	250 – 270
Molding temperature	(°C)	30 – 80	30 – 100
Injection rate	(mm/sec)	10 – 40	10 – 40
Injection pressure	(MPa)	60 – 90	60 – 90
Cycle time	(sec)	100 – 200	100 – 200

Examples of Co-extrusion Molding: Multi-Layer Tube (8φ)

Layer design			Die, drawing		
Total thickness	(mm)	1	Die	(°C)	280
Inner layer thickness	(mm)	0.25	Die/tip	(mm/mm)	16/12
Outer layer thickness	(mm)	0.75	Line speed	(m/min)	8

Inner-layer extruder (for RP-5000)			Outer-layer extruder (for Nylon 12)		
Cylinder diameter	(mm)	30	Cylinder diameter	(mm)	40
Screw L/D		24	Screw L/D		24
Compression ratio		3.0	Compression ratio		3.0
Cylinder temperature			Cylinder temperature		
C1	(°C)	260	C1	(°C)	210
C2	(°C)	260	C2	(°C)	220
C3	(°C)	260	C3	(°C)	230
Adapter	(°C)	265	Adapter	(°C)	245

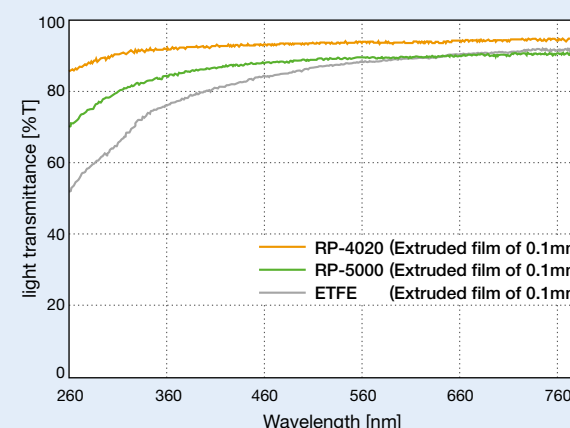
Improved Transparency



NEOFLON EFEP can also be used in applications requiring transparency. Transparency to light has been improved by about 30%*. (RP-4020)

Transparency to light has been improved while keeping the features of a fluoropolymer. NEOFLON EFEP can certainly be used in applications where visual observation plays an important role such as chemical tubes and level indicators, but it also shows excellent performance in applications where not only the transparency but also durability and weather resistance are required such as surface films for solar cells and roofing materials (transparent films).

*Compared with ETFE (thickness: 500μm)



Inheriting Desirable Features from Fluoropolymers

Excellent functionality unique to fluoropolymers contributes to improvements in quality.

Desirable features are entirely inherited from fluoropolymers including chemical resistance, non-stick properties, electrical insulating properties, weather resistance and slipping properties.

Physical Properties of NEOFLON™ EFEP

General Properties of NEOFLON EFEP

Property	ASTM Test method	E F E P			
		RP-4020	RP-5000	ETFE	PVdF
Specific gravity	D-792	1.72~1.76	1.72~1.76	1.72~1.76	1.76~1.78
Melting point (°C)	—	155~170	190~200	260~270	173~175
Decomposition temperature (°C)	1wt%(air)	355	380	—	—
MFR (g/10min)	5kg load	25~50	20~30	8~16	1~2
	(Measuring temperature; °C)	(265)	(265)	(297)	(297)
Tensile strength (MPa)	D-638	42~50	44~51	42~47	40~50
Tensile elongation (%)	D-638	420~530	390~440	420~450	50~250
Flexural modulus (MPa)	D-790	1300	1000	880~1270	1370~1760
Haze value	3mm thick sheet	12	47	85	92
Contact angle (deg)	With water	96	96	96	82
Dielectric constant	2.45GHz, D-150	2.07	2.14	2.19	2.59
Dielectric Dissipation factor	2.45GHz, D-150	0.014	0.014	0.018	0.064

Chemical Resistance of NEOFLON EFEP

(a) Resist to inorganic chemicals (70°C, immersed for one month)

Chemical	Evaluation standards	EFEP	ETFE	PVdF
HCl (36%)	Change of weight A : 0 to +0.5% B : +0.5% to +3% C : +3% and higher	A	A	A
HNO ₃ (60%)		A	A	B
H ₂ SO ₄ (98%)		A	A	A
HF (50%)		A	A	A
H ₂ O ₂ (30%)		A	A	A
NH ₄ OH (28%)		A	A	C

(b) Resist to organic chemicals (40°C, immersed for one month)

Chemical	Evaluation standards	EFEP	ETFE	PVdF
Isooctane	Change of weight A : 0 to +3% B : +3% to +10% C : +10% and higher	A	A	A
Toluene		A	A	A
Acetone		B	B	C
Ethyl acetate		B	B	C
Triethylamine		A	A	A
DMF		A	A	C
NMP	A	A	C	

NEOFLON EFEP can be used not only for automobile fuel tubes but also in a variety of applications such as chemistry, semiconductors, electricity, electronics and construction.

Automobile fuel tubes



NEOFLON EFEP is laminated on the inside of a nylon tube. This significantly reduces fuel permeability, conforming to U.S. environmental protection regulations.

Tubes for chemicals (multi-layer)



NEOFLON EFEP is laminated on the inside of a semi-transparent nylon tube. This significantly enhances chemical resistance and prevents degradation of the tube and smudges on the surface. Applications in chemical engineering, semiconductors, etc. are better served.

Transparent tubes for chemicals



When used with transparent tubes for chemicals, NEOFLON EFEP provides excellent chemical resistance and promises greater enhanced visibility for the liquid flowing inside. Applications in chemical engineering, semiconductors, etc. are better served.

NEOFLON EFEP RP-4020 is used.

Transparent bottles for chemicals



When used with transparent bottles for chemicals, NEOFLON EFEP provides excellent chemical resistance and promises greater enhanced visibility for the liquid inside the bottle. Applications in chemical engineering, semiconductors, etc. are better served.

NEOFLON EFEP RP-4020 is used.

Films



When used with films, NEOFLON EFEP provides excellent weather resistance and transparency. Applications such as covering material for solar cells, wall-coverings, etc. are better served.

- The following points should be followed to ensure safety when handling NEOFロン EFEP.
 - **WARNING: VAPORS HARMFUL IF INHALED.**
The work area should be adequately ventilated at all times, because HF, COF₂ begin to be produced at approximately higher than 110°C and the volume increases at approximately 260°C .
If EFEP is incinerated, the acidic gases must be removed by alkaline scrubbing techniques.
 - Personnel should be cautioned against inhaling the fumes liberated during processing and provided with suitable protective equipment.
 - Smoking should be prohibited in work areas, since smoking fluoropolymer contaminated tobacco may result in inhalation of decomposed gas. Do not bring tobacco in the work area.
 - Avoid breathing dust and contact with eyes.
 - Wash hands and face after handling.
 - Waste generated during processing should be treated by waste treatment specialists and/or licensed waste contractor disposed of in accordance with federal, state and local waste disposal regulations.
 - Read the "Material Safety Data Sheet" before use.
- **MEDICAL USE:** This product is not specifically designed or manufactured for use in implantable medical and/or dental devices. We have not tested it for such application and will only sell it for such use pursuant to contract containing specific terms and conditions required by DAIKIN.

DAIKIN INDUSTRIES,LTD. and DAIKIN AMERICA, INC. have obtained the ISO 14001(*1) certification which is an International Standard concerning the environmental management system. DAIKIN INDUSTRIES, LTD. has obtained the ISO 9001(*2) and DAIKIN AMERICA, INC. has obtained the ISO 9002 (*3) .

*1. ISO 14001 is a standard established by the ISO (International Organization for Standardization) which applies to environmental preservation activities. Activities, products and services of our fluorochemicals plant have been certified as being environmentally sound by an internationally recognized certification body.

*2. ISO 9001-2000 is a certification system for quality control established by the ISO which certifies our quality control system concerning our products .

*3. ISO 9002-1994 is a plant certification system for quality control established by the ISO which certifies our quality control system concerning manufacture and inspection of the products manufactured at our plant (division).

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DAIKIN INDUSTRIES, LTD.

Umeda Center Bldg.,
2-4-12, Nakazaki-Nishi, Kita-ku,
Osaka 530-8323, Japan.
Phone: +81-6-6373-7287
Facsimile: +81-6-6373-4390
URL:www.daikin.co.jp/chm

DAIKIN CHEMICAL INTERNATIONAL TRADING (SHANGHAI) CO.,LTD.

2201 Bund Center, 222 Yan An Road(East),
Shanghai China Zip Code :200002
Phone: +86-(0)21-6335-0011
FAX: +86-(0)21-6335-0700

DAIKIN AMERICA, INC.

20 Olympic Drive
Orangeburg, NY 10962, USA,
Phone: +1-845-365-9500
Tool-Free: +1-800-365-9570
Facsimile: +1-845-365-9598
URL:www.daikin.cc

TAIWAN DAIKIN ADVANCED CHEMICALS,INC. (TAIPEI Head Office)

8F-E, No.168, Tun-Hwa N. Rd., Taipei,
Taiwan.
Phone: +886-(0)2-2547-1269
FAX: +886-(0)2-2547-1279

DAIKIN CHEMICAL EUROPE GmbH

Immermannstr. 65D
40210 Dusseldorf, Germany
Phone: +49-211-179225-0
Facsimile: +49-211-1640732