High-performance fluorinated special gas

FITECT™

(CF_3I / trifluoroiodomethane)

TOSOH FINECHEM CORPORATION

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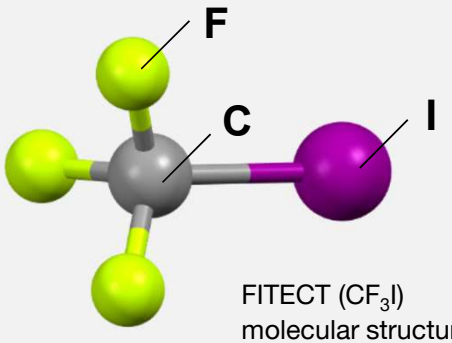
What is FITECT (CF_3I)?

FITECT (CF_3I) is an environmentally friendly special gas that serves as an alternative to chlorofluorocarbons (CFCs).

Tosoh Finechem is the first company in the world to succeed in mass production[1] with our proprietary technology and provide high-quality products.



FITECT (CF_3I)
molecular structure

[1]Japan's New Energy and Industrial Technology Development Organization (NEDO) project "Mass production of CFC and halon substitute materials by the world's first synthesis method (2013)"
https://www.nedo.go.jp/hyoukabu/articles/201207f_tech/index.html

Three key features of FITECT (CF_3I)

Superior environmental characteristics

Short atmospheric lifespan (= 0.005 years)

Low GWP[1] (= 0.4) / Low ODP[2] (= 0)

Application: CFC alternative, etching gas

Non-combustibility

High fire extinguishing performance (flame extinction concentration = 3.0 vol%)

Application: Fire extinguisher, cover gas for Mg casting

High reactivity

Labile C-I bond (= 2.4 eV)

Application: Trifluoromethylation reagent

1 GWP: Global warming potential (CO_2 = 1)

2 ODP: Ozone depletion potential

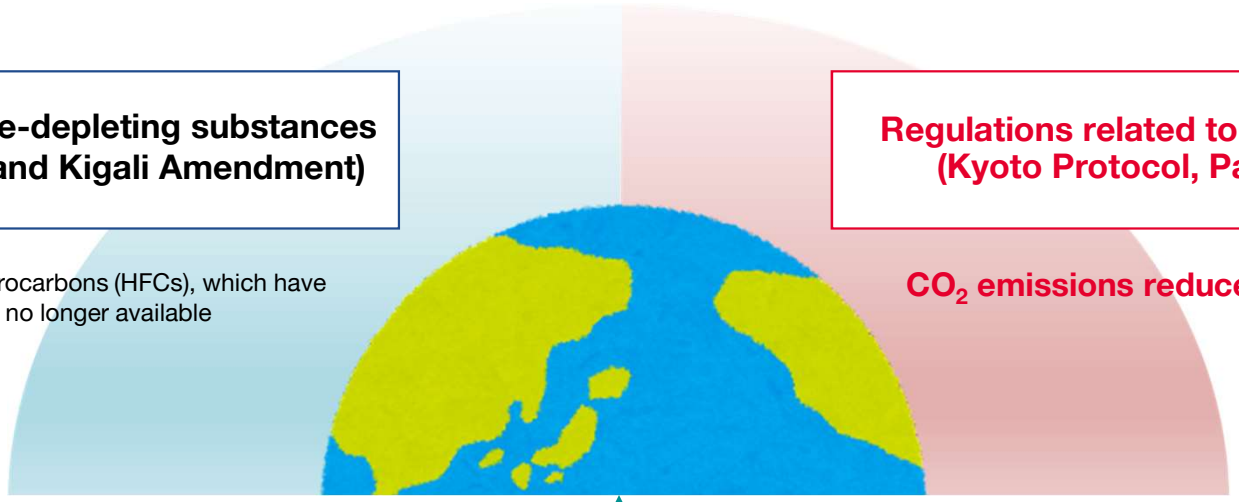
Environmental regulation trends

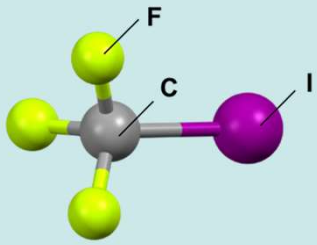
Regulations on ozone-depleting substances (Montreal Protocol and Kigali Amendment)

CFC alternative hydrofluorocarbons (HFCs), which have high GWP[2], are no longer available

Regulations related to greenhouse gases (Kyoto Protocol, Paris Agreement)

CO_2 emissions reduced to virtually zero





Low ODP[1] (= 0)

Low GWP[2] (= 0.4)

FITECT (CF_3I) is capable of meeting today's environmental regulations.

1 ODP: Ozone depletion potential
2 GWP: Global warming potential (CO_2 = 1)

Environmental characteristics comparison

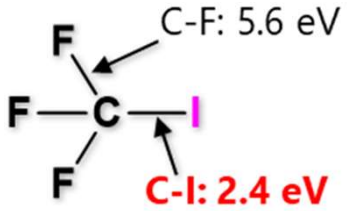
Item	FITECT (CF_3I)	CF_3Br	CF_4	CHF_3	SF_6	CF_3CH_2F
Abbreviation	-	Halon-1301	FC-14	HFC-23	-	HFC-125
Atmospheric lifespan (years)	0.005	65	50,000	222	3,200	13
ODP[1]	0	19	0	0	0	0
GWP[2]	0.4	6,290	6,630	12,400	23,500	1,300

Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

1 ODP: Ozone depletion potential

2 GWP: Global warming potential (CO_2 = 1)

FITECT (CF_3I) has a labile C-I bond and decomposes easily in the atmosphere. It is an environmentally friendly gas with a GWP of less than 1/1000 of conventional fluorinated gases.



FITECT (CF_3I) molecular structure

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Cover gas for Mg casting application

PFAS regulation NOT applicable

Mg alloys are lightweight, high strength, and highly workable. When melting (over 600℃), cover gas is used to prevent ignition from the surface of the molten Mg.

Wheel

Laptop

Drone

Alloy Type	Cover gas	GWP (CO_2=1)	Flame retardant properties	Alloy properties		
			Flameproof temperature [℃]*1	Yield strength @0.2% [MPa]	Tensile strength [MPa]	Growth rate [%]
AZ91D	SF_6	23,500	650 ~ 800	116	202	5.7
	FITECT (CF_3I)	0.4	650 ~ 800*2	115	213	6.4

*1) When carrier gas is CO_2.

*2) 650~750℃ : No ignition occurs.800℃ : ignition occurs, but disappears quickly or does not increase.

FITECT (CF_3I) provides high flame retardant properties, high alloy properties and low GWP.

Fire extinguisher applications

Item	FITECT (CF_3I)	Inert gas		Fluorine fire extinguisher
		N_2	CO_2	CF_3Br (halon 1301)
Flame extinction concentration (vol%)	3.0	34	22	3.4～7.0
GWP (global warming potential)	0.4	0	1	7140
State of storage	Liquefied gas	Compressed gas	Liquefied gas	Liquefied gas
Fire extinguishing principles	Inhibition of combustion chain reaction	Smothering		Inhibition of combustion chain reaction

FITECT (CF_3I) can efficiently extinguish fire with a small amount of gas and is being considered as a fire extinguishing agent with low environmental impact.

Outdoor tank

Data center

Art museum

Aircraft

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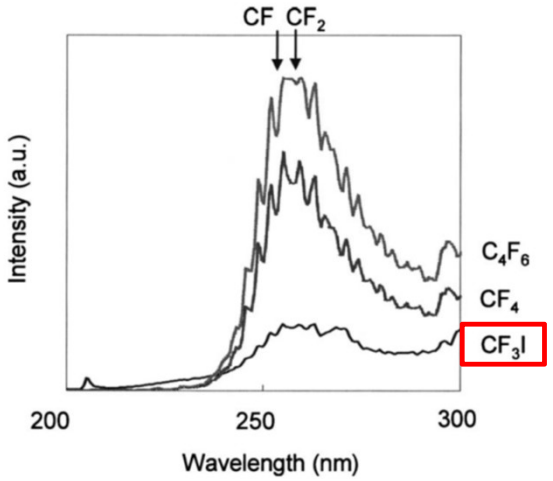
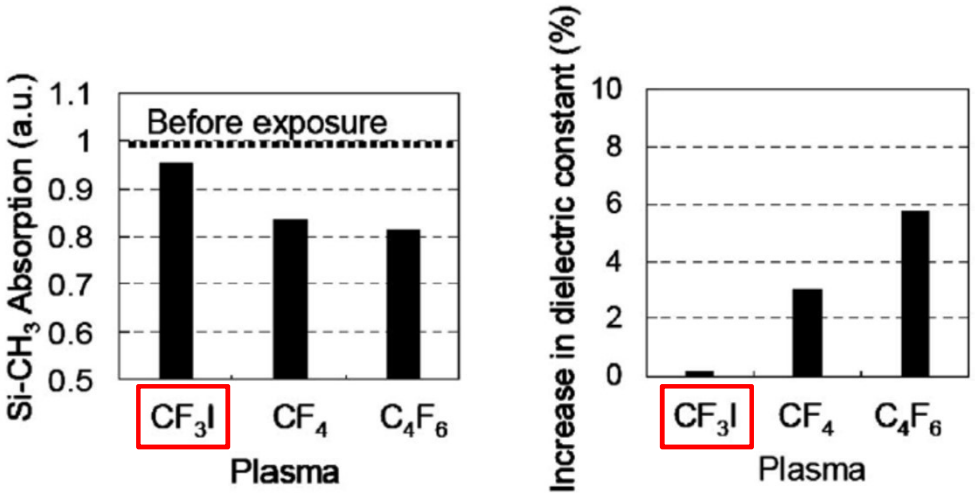
Etching gas application 1

UV intensity in plasma



Effect on low-k film (SiOC film)



Compared to other fluorine-based gases, FITECT (CF_3I) has a lower UV intensity in plasma, which reduces damage to low-k films (SiOC films) and enables etching without damaging film characteristics (low dielectric constant).

J. Vac. Sci. Technol. A **2008,** *26*, 875–880.

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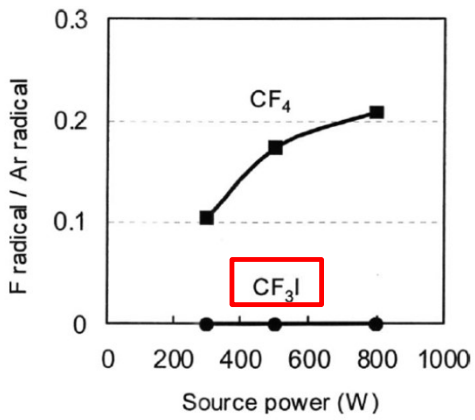
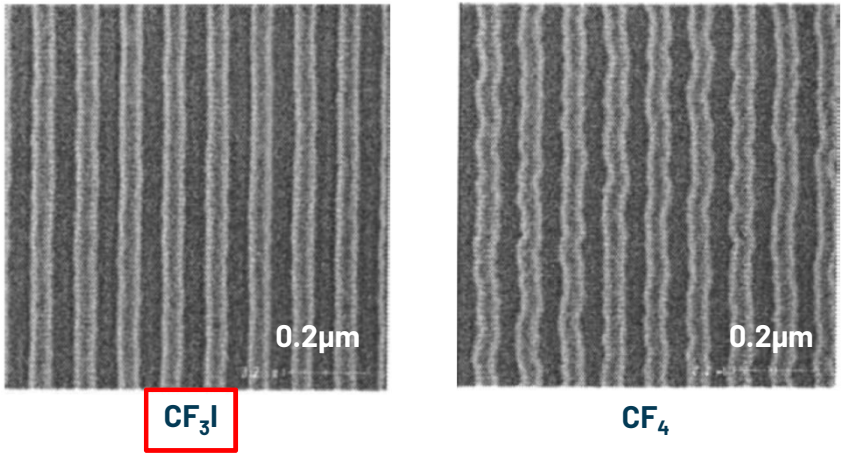
Etching gas application 2

Amount of F radical in plasma



Wiring sidewall roughness (line edge roughness; LER)
50 nm half-pitch



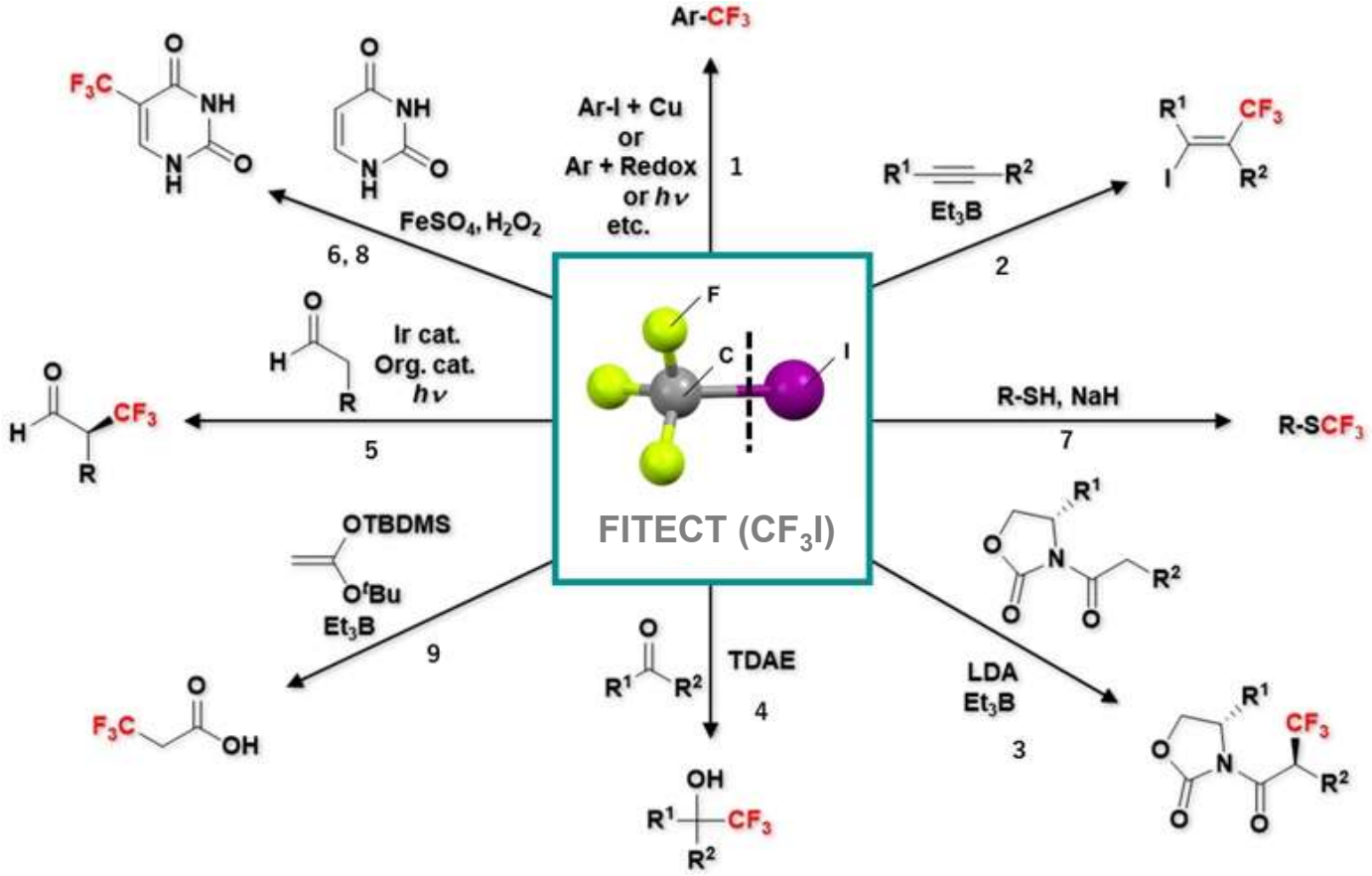
FITECT (CF_3I) produces fewer F radicals than other fluorinated gases, resulting in lower LER and higher resist selectivity.

J. Vac. Sci. Technol. B **2009**, *27*, 2, 649–653.

J. Vac. Sci. Technol. B **2009**, *27*, 5, 2117–2123.

Reagent applications

FITECT (CF_3I) reacts with various substrates and can introduce CF_3 groups, which are indispensable for pharmaceutical and agrochemical intermediates.



1) Tetrahedron Lett. 1969, 10, 4095-4096.
2) Tetrahedron Lett. 1989, 30, 3159-3162.
3) Tetrahedron Lett. 1993, 34, 2169-2170.
4) Org. Lett. 2001, 3, 4271-4273.
5) J. Am. Chem. Soc. 2009, 131, 10875-10877.
6) J. Fluorine Chem. 2010, 131, 98-105.
7) J. Fluorine Chem. 2011, 132, 1241-1246.
8) License No. 50536222
9) Tetrahedron Lett. 1996, 34, 1829-1832.

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Basic information

Item	Contents
Name	Trifluoroiodomethane
CAS RN	2314-97-8
Molecular weight	195.9
Appearance	Colorless gas（20°C）
Boiling point (°C)	−22.5
Steam pressure (MPa)	0.427 （20°C）
Gas density (air = 1)	6.8 （Calculated value）
Liquid density (g/mL)	2.095 （25°C）

Appearance during pressurized liquefaction

Product packaging

10 L cylinder

47 L cylinder

440 L cylinder

Other packaging are also available.

Safety and regulations

Safety items	Result
LC_{50}	27.4% – 4 hrs.（rats）
Ames test	Positive
Chromosome aberration test	Positive (micronucleus test)
Work environment concentration	500 ppm（8h, TWA）
Bone marrow chromosome aberration test	Negative
Irregular DNA synthesis test	Negative
Carcinogenicity test	Not suspected to be carcinogenic
Repeated dose toxicity study	No effect (rats, 28 days)

Toxicol. Ind. Health. 2020, 36, 310-321.

Safety and regulations

List name	Registration information
TSCA (US)	Yes
DSL (Canada)	No
REACH (Europe)	Pre-registered
AICS (Australia)	Yes
MITI (Japan)	No
KECL (Korea)	Yes

Tosoh Finechem Corporation

Location

Sales Headquarters: 2-1Yaesu 2-chome, Chuo-ku, Tokyo 104-0028, Japan
Head Office and Factory: 4988 Kaisei-cho, Shunan, Yamaguchi Prefecture 746-0006, Japan

Business

Organometallic compounds: Aluminum alkyls, aluminoxanes, organometallics
Bromine compounds: NaSS, styrene derivatives, alkyl bromides
Fluorine compounds: TFEA, FITECT (CF_3I), fluorine compounds