LUMIFLON®
FEVE RESIN

when the standard's just not enough

AGC Chemicals
Chemistry for a Blue Planet

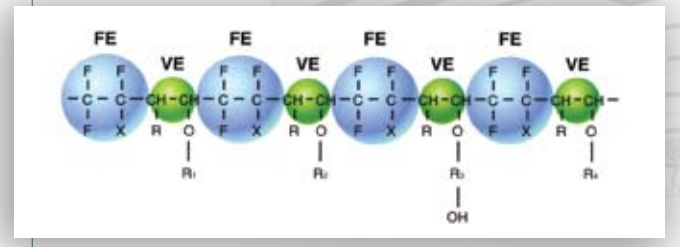
since *1907*

LUMIFLON is one of many quality products made by AGC – Asahi Glass Company – established in Japan in 1907. In just over a century, AGC has gone from a small glass company to a diversified, multi-billion-dollar enterprise. AGC first developed its solvent-soluble LUMIFLON fluoropolymer in 1982 – and it didn't take long for manufacturers to discover that this resin was different. LUMIFLON resins allow coatings to be cured at room temperature. For the first time, the durability, weatherability and long-term cost effectiveness of fluoropolymer coatings were now available for field application. With their superior performance and life cycle cost advantages, it's no wonder fluororesin paints based on LUMIFLON have since been produced by many manufacturers and applied to more than 150,000 industrial and architectural structures, aircraft and automobiles worldwide.

LUMIFLON is just one of the many innovative products and materials created by AGC, a company that's driven to excel in a high-tech world. But what a difference it makes for manufacturers and builders who demand the combination of quality and value that only LUMIFLON delivers.

polymer structure of lumiflon

LUMIFLON is known generically as an FEVE resin. Its unique alternating structure is key to its ultra-weatherability.



FE: fluoro ethylene

Durability

VE: vinyl ether

R1=Transparency, Gloss, Hardness

R2=Flexibility

R3=Crosslinkability

R4=Pigment compatibility, adhesion

why *lumiflon*

1 aesthetics:

LUMIFLON-based coatings offer brilliant, long-lasting colors with a wide gloss range. They simply look great – and keep looking great year after year.

2 corrosion prevention:

LUMIFLON's unique chemical structure improves resistance to corrosion from water, oxygen and even chloride ions, ensuring a longer life for industrial structures like bridges with far less need for repainting.

3 sustainability:

With its long lifespan, LUMIFLON eliminates the environmental impact of repeated repainting and recoating – just one of the reasons LUMIFLON coatings can contribute to LEED certification.

4 outperforms the competition:

No other coating type can match LUMIFLON's combination of attractiveness, application flexibility and – as tests and studies confirm – long life and weathering resistance.

5 lower life cycle cost:

Because they last so much longer, LUMIFLON-based coatings can substantially reduce any project's life space cycle costs, including maintenance costs, replacement costs and recoating costs.

name: coss y leon building, mexico
substrate: aluminum composite material
market: architectural

name: tsurumi tsubasa bridge, japan
substrate: concrete, steel
market: industrial maintenance

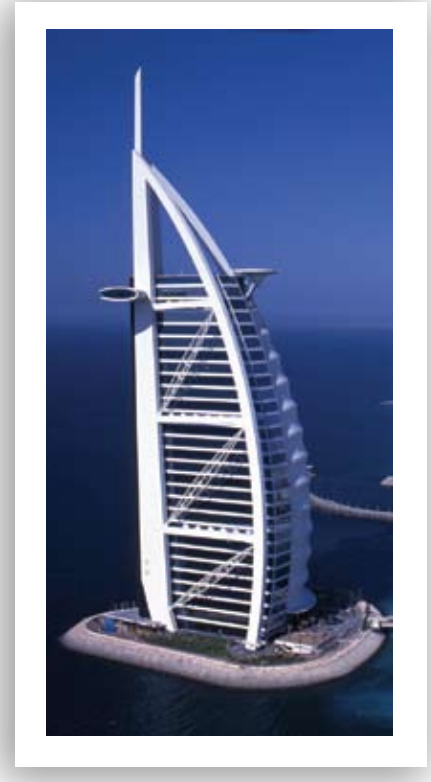
aesthetics

Because LUMIFLON-based coatings offer crisp, clean colors and a wide range of gloss, designers and builders choose them to achieve a superior look from day one. And with LUMIFLON's ability to resist UV degradation, corrosion, and the ill effects of chemical exposure, projects using LUMIFLON continue looking good for years to come with little or no maintenance required. That means markedly less fading, discoloration and chalking for the life of the coating – estimated at up to 60 years! Meanwhile, AGC's research and development team continues to press LUMIFLON's aesthetic advantage with new FEVE resin formulations that add even more improvements, like the ability to resist dirt and grime.

bridge after fourteen years

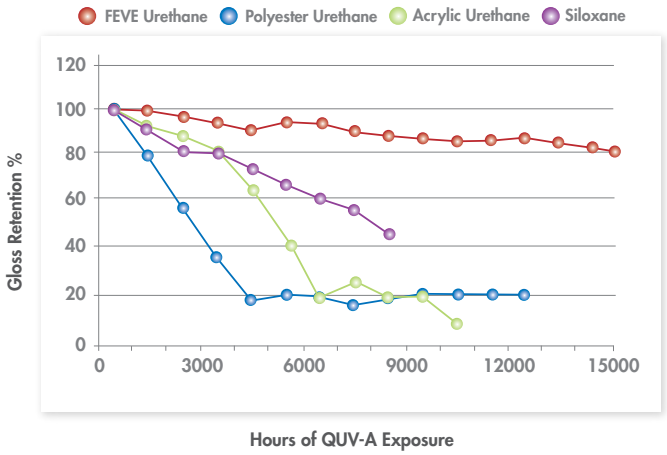
name: daiichi mukaiyama bridge, japan
when: 1987
where: mountain area
new/repaint: new
how long: 14 years

LUMIFLON: gloss is still high



name: burj al arab hotel, dubai u.a.e.
substrate: aluminum composite material
market: architectural
photo by Satoru Mishima, Nikkei BP

FEVE resin topcoats accelerated weathering QUV-A (ASTM D4587)



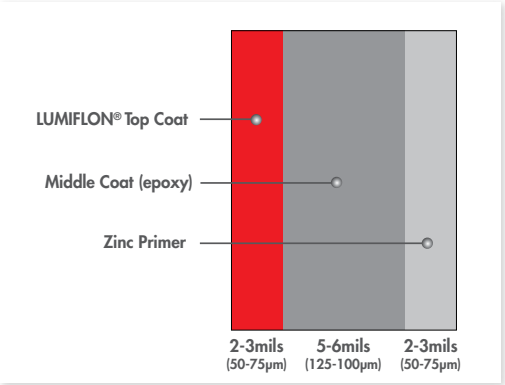
corrosion resistance

Corrosion is a major problem that can dramatically add to a project's life cycle costs, especially for bridges, water towers and other metal structures.

A LUMIFLON-based coating:

- Resists degradation due to weathering and exposure to chemicals
- Over the course of many years, loses little of its thickness
- Keeps corrosion initiators from penetrating the topcoat and degrading the zinc-rich primer underneath
- Has an estimated coating life of 60 years or more

cross section of coating system

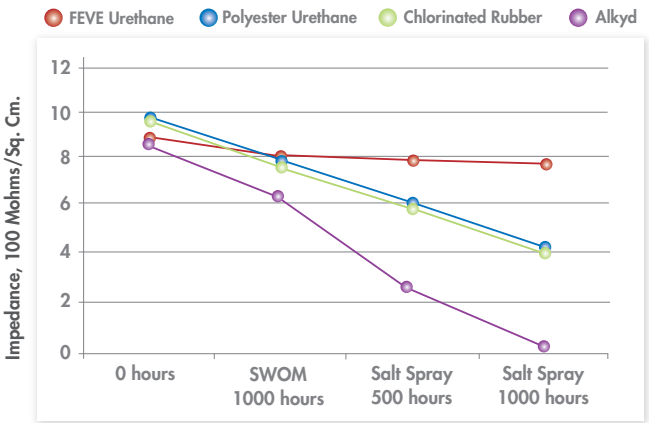


corrosion resistance of LUMIFLON FD-1000: salt fog test

product (NCO index)	LUMIFLON FD-1000 (1.0)	polyurethane dispersion[1] (1.0)	polyurethane dispersion[1] (1.5)
coating system	primer[2]/topcoat/topcoat		
salt spray, 1000 hours	good (rating 0)	good (rating 0)	very slight blisters 1mm (rating 1)
salt spray, 1500 hours	good (rating 0)	slight blisters, 1mm (rating 2)	slight blisters 2mm (rating 2)

[1]Bayhydrol 145 (Bayer Corp.)
[2]Waterborne 2K epoxy primer

electrochemical impedance spectroscopy



Accelerated Weathering Followed by Salt Fog Test

Corrosion resistance is directly related to the slope of the line. The lower the angle difference from horizontal, the better the corrosion resistance.

name: kiyosu bridge, japan
substrate: steel
market: industrial maintenance

name: ntt sekimoku network center, japan
substrate: steel
market: industrial maintenance

name: water tower, usa
substrate: steel
market: industrial maintenance

name: rosemont water tower, usa
substrate: steel
market: industrial maintenance

sustainability

The weatherability, longevity and the ability to formulate low VOC coatings with LUMIFLON resins are all features that contribute to its sustainability, a concept meaning: "to reduce consumption of non-renewable resources, minimize waste, and create healthy, productive environments" (www.gsa.gov).

"Reduce consumption of non-renewable resources"

LUMIFLON coatings can last up to 30 years without fading, reducing life cycle costs related to the maintenance, re-application and/or replacement of underlying surfaces. On existing roofs, a LUMIFLON topcoat can stop the degradation of the underlying reflective coating, thus extending the life and solar reflectance capability of the roof and minimizing the use of raw materials derived from oil.

"Minimize waste"

By extending the life of roof and wall systems, LUMIFLON topcoats reduce waste created from disposal of damaged roofing and walls; avoid energy consumption in the production, transportation and installation of new systems; and maintain energy and equipment savings from continued high-performance of the building envelope. In addition, the energy consumed in removing a coating from a building or structure can be avoided through the use of a new paint product containing a LUMIFLON clearcoat with excellent durability and weatherability.

"Create healthy, productive environments"

There are four types of LUMIFLON resins, three of which – solid, powder, and emulsion grades contain either zero volatile organic compounds (VOCs) or can be formulated to contain less than 50 g/L of VOCs, meeting the most stringent green building criteria in the US.

Due to its longevity, LUMIFLON reduces the environmental impact associated with production, transportation (energy consumed, greenhouse gases emitted), and VOCs off-gassed during the repainting/recoating process.

gloss and color retention of tokiwa bridge

october 1988

april 1993

april 2007

initial gloss	final gloss	gloss retention	color change
75	69	91%	ΔE=3.5

outperforms the competition

Industry insiders know that, from buildings and bridges to water towers and automobiles, LUMIFLON-based coatings look great. But they look even better when cold, hard data comparing LUMIFLON with high-performance polyesters and other competitors are collected from tests and studies conducted in laboratories, simulators and harsh, real-world environments.

Advantages of FEVE Based Coatings

- Ambient or elevated temperature cure – field or shop applied coatings
- Solvent soluble – clean crisp colors and a wide gloss range
- Versatile – solvent grade, solid, water based and powder coating resins offered
- OH functional – polyurethane chemistry, use standard paint equipment
- Fluoropolymer segments – ultra-weatherable and corrosion resistant
- Longer life cycle – up to 60 years

Alkyd coating is peeling

LUMIFLON coating: no chalking or peeling

Alkyd coating: chalking and color fade have occured

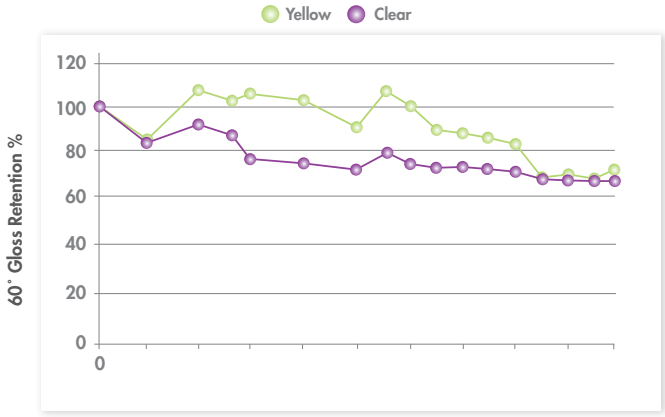
LUMIFLON vs. pvdf

	LUMIFLON	pvdf
resin type	solution	solvent dispersion
curing temperature	room temp. to 230˚C	>250˚C
60˚ gloss	5 to 90	5 to 35
color range	>230 colors	color selection is limited
recoatability	excellent	difficult

name: ferrari world, abu dhabi u.a.e.
substrate: aluminum
market: architectural

The results confirm what you see with your own eyes every time you look at an attractive, long-lasting LUMIFLON coating all over the world; LUMIFLON outperforms the competition.

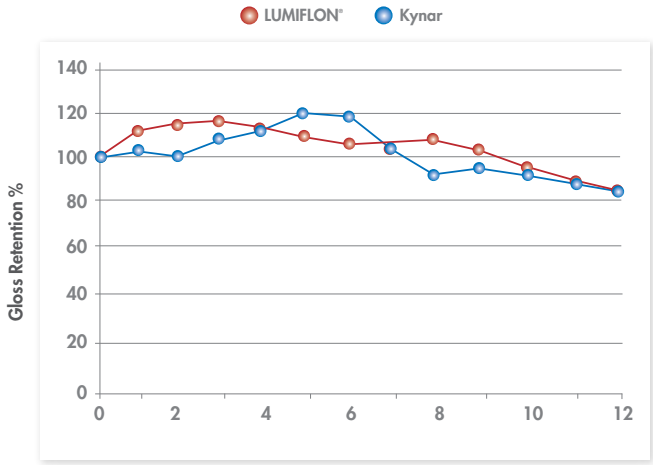
natural exposure test on LUMIFLON
Miami, Florida (ASTMG7)



Exposure Time (Years)
Florida exposure test on LF-200
Direct 30° south, open back

name: boeing 787 airplane
substrate: aluminum alloy l composites
market: aerospace

Okinawa weathering chart



Exposure Time (Years)
Okinawa Exposure Test

name: stadium seats, japan
substrate: fiberglass
market: architectural

lower life cycle cost

There are those who make buying decisions based on price – and then there are those who are more interested in value. With LUMIFLON, the difference is clear.

- LUMIFLON-based coatings maintain gloss and color when applied to buildings, bridges, water towers, and other structures for between 20 and 60 years – significantly longer than other coating types.
- LUMIFLON resins protect steel, aluminum, fiberglass, concrete, and other materials from corrosion, sun, wind, rain and chemical exposure.

Over time, all that protection also protects your bottom line. Total life cycle costs, factoring in savings on maintenance, recoating and replacement, are much lower with LUMIFLON. Based on results from numerous projects, it's estimated that the life cycle cost of LUMIFLON coatings is only 40-80% of that of polyurethane. Price versus value. Over the course of a project's lifetime, the difference can be monumental.

Life Cycle Cost Advantages

- **Initial applied cost of FEVE-based topcoat:**
  5-10% higher than standard polyurethane topcoat
- **FEVE-based topcoat life expectation:**
  30-60+ years
- **Expected maintenance of standard polyurethane topcoat in this time frame:**
  2-3 repainting cycles
- **Additional costs of repainting:**
  Asset downtime
  Staging costs
  Environmental costs
  Emissions and CO_2 from equipment

name: bullet train "max"
substrate: steel
market: transportation

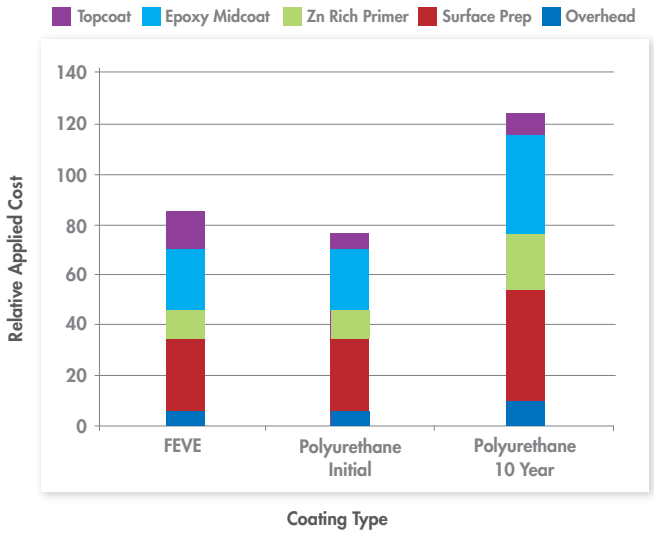
name: c-17 airplane
substrate: aluminum alloy
market: aerospace

name: chevy cruze
substrate: epdm & silicone
market: automotive

comparative life cycle costs: LUMIFLON coating and chlorinated rubber coating

coating type	process	cost, $/m²	initial cost ratio	coating life, years	cost/year, $/m²
chlorinated rubber	surface preparation	$10.08	0.19		
	staging	$27.48	0.52		
	coating	$15.53	0.29		
	TOTAL	**$53.09**	**1.00**	**8**	**$6.64**
LUMIFLON coating	surface preparation	$10.08	0.19		
	staging	$35.08	0.66		
	coating	$32.98	0.62		
	TOTAL	**$78.14**	**1.47**	**>21**	**$3.72**
	LCC Ratio				**0.56**

life cycle cost analysis



name: okayama castle, japan
substrate: concrete
market: architectural

lumiflon *products*

solvent grades

LUMIFLON solvent grade typical properties

grade	LF-810	LF-552	LF-600X	LF-200	LF-910LM
characteristics	single component coatings	improved flexibility	improved flexibility	standard	lower VOC
application type	field application aerosols	factory coil coating	factory coil coating field application	field application	field application
markets	architecture, industrial maintenance, transportation, aerospace				
substrates	metal-steel & aluminum, plastic, fiberglass, concrete				
molecular weight	high	high	high	moderate	low
solid resin, wt%	45	40	50	60	66
Tg, ˚C/F	45/113	20/68	20/68	35/95	37/99
specific gravity (as varnish), 25˚ C	0.98	1.06	1.08	1.12	1.16
OH value, mg KOH/g-polymer	4	52	57	52	100
acid value, mg KOH/g-polymer	0.3	5	0	0	0
viscosity, stokes, cm²/s, 25˚ C	18	4	9	20	5
solvent	mineral spirits	aromatic hydrocarbon solvent/cyclohexanone	xylene	xylene	xylene

LUMIFLON aerospace resins typical properties

grade	LF-9716	LF-9721	LF-910LM
markets	aerospace, other military		
substrates	aluminum, composites, steel		
solid resin, wt%	70	70	66
specific gravity, 25˚ C	1.25	1.26	1.16
OH value, mg KOH/g-polymer	170	160	100
gardner color	<1	<1	<1
viscosity, stokes, cm²/s, 25˚ C	35	30	5
solvent	ethyl 3-ethoxy propionate	ethyl 3-ethoxy propionate	xylene

solid grades

LUMIFLON solid grade typical properties

grade	LF-200F	LF-916F
markets	architecture, industrial maintenance, transportation, aerospace	
substrates	metal-steel & aluminum, plastic, fiberglass, concrete	
appearance	pale yellow flake	pale yellow flake
solid resin, wt%	>98	>99
OH value, mg KOH/g-resin	49	100
Tg, ˚C/F	35/95	34/93
Density, glcc, 25˚ C	1.42	1.39
softening point, ˚C	119	117

water emulsion grades

LUMIFLON emulsion grade typical properties

grade	FE-4300	FE-4400	FE-4500
characteristics	low OH value/low Tg one component	high OH value/high Tg one or two component	low OH value/low Tg one component
markets	architecture, industrial maintenance, transportation		
substrates	metal-steel & aluminum, plastic, fiberglass, concrete		
solid resin, wt%	50	50	50
specific gravity, 25˚ C	1.13	1.16	1.17
OH value, mg KOH/g-polymer	10	49	13
pH	7-9	7-9	7-9
average particle diameter, µm	0.1-0.2	0.1-0.2	0.1-0.2
ionic character	Anionic	Anionic	Anionic
minimum film forming temperature, ˚C/F	30/86	55/131	28/82

water dispersion grade

LUMIFLON dispersion grade typical properties

grade	FD-1000*
markets	architecture, industrial maintenance, transportation, aerospace
substrates	metal-steel & aluminum, plastic, fiberglass, concrete
appearance	milky white liquid
solid resin, wt%	40
specific gravity, 25˚ C	1.13
OH value, mg KOH/g-polymer	85
acid value, mg KOH/g-polymer	15
pH	7-9
average particle diameter, µm	0.05-0.15
ionic character	Anionic
minimum film forming temperature, ˚C/F	29/84

powder coating grades

LUMIFLON powder coating grade typical properties

grade	LF-710F	EXLP-36*
markets	architecture, transportation	
substrates	metal-steel & aluminum	
solid resin, wt%	>99	>99
Tg, ˚C/F	51/125	50/122
OH value, mg KOH/g-polymer	46	52
softening point, ˚C/F	90/194	118/244
solvent	none	none

*Commercial development products

solvent grades

name: spectrum building, usa
substrate: aluminum composite material

name: akashi straits bridge, japan
substrate: steel

name: rosemont water tower, usa
substrate: steel

solid resins

name: twin dragon towers gateway, usa
substrate: steel

name: aon center, usa
substrate: aluminum composite material

water emulsion resins

name: stadium seats, japan
substrate: fiberglass

name: mihama estate, japan
substrate: fiber reinforced concrete

name: okayama castle, japan
substrate: concrete

powder coating

name: the birmingham news, usa
substrate: aluminum

name: richmond city hall, usa
substrate: aluminum composite material

Superior durability and weatherability. More brilliant, longer lasting colors and a far wider gloss range. And the toughest, most durable finish ever with the industry's leading longevity record. Add LUMIFLON's unique capabilities for field application and you have an end product that looks better, longer – and ultimately costs less. Longer life is also a formula for sustainability, which is good chemistry for a blue planet. For more information on LUMIFLON's applications worldwide, please call 800-424-7833, 610-423-4300 or visit www.lumiflonusa.com. Discover for yourself how good your bottom line looks when you raise your own standards with LUMIFLON.

For additional information please visit www.lumiflonusa.com.

AGC Chemicals Americas, Inc.
55 East Uwchlan Avenue, Suite 201, Exton PA 19341 USA
ph. 1-610-423-4300 toll free (US only) 1-800-424-7833
www.lumiflonusa.com, e-mail: AGCChemicalsLumiflon@us.agc.com

Asahi Glass Co., Ltd.
AGC Chemicals Tokyo Office
1-5-1 Marunouchi, Chiyoda-ku, Tokyo 100-8405, Japan
ph. +81 3 3218 5040

AGC Chemicals Asia Pacific, Ltd.
460 Alexandra Road #30-02, PSA Building, Singapore 119963
ph. +65 6273 5656

AGC Chemicals Trading (Shanghai) Co., Ltd.
2701-2705 Metro Plaza, No 555 Lou Shan Guan Road, Shanghai, China 200051
ph. +86 21 6386 2211

AGC Chemicals Europe, Ltd.
World Trade Center, Zuidplein 80, H-Tower 1077 XV Amsterdam, The Netherlands
ph. +31 20 880 4170

LUMIFLON®
FEVE RESIN