

3M™ Novec™ Fluorosurfactants  
For Paints and Coatings



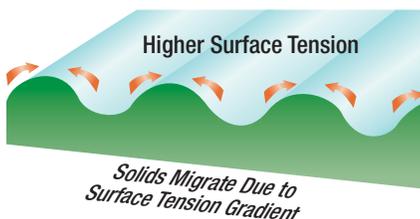
# The Science of Smooth

- Lowers surface tension
- Helps paints and coatings overcome surface contamination
- Effective in both aqueous and solvent-based systems

**3M**

## Advanced Wetting and Leveling Agents for

# Smoother, Defect-Free Finishes



If a coating contains components of different surface tensions, the solids will tend to migrate, resulting in an “orange peel” effect.

Novec fluorosurfactants concentrate at the liquid surface, lowering the surface tension of the liquid. This allows the liquid to wet and spread more evenly, and reduces the possibility of surface defects.

Contamination, surface defects and hard-to-wet surfaces cause all manner of problems in paints and coatings. Unsightly “orange peel,” cratering, “fish eyes” and picture framing effects are just some of the problems formulators face.

To address these defects, surfactants are added. Surfactants decrease a coating’s surface tension to allow better leveling, wetting and spreading – especially on unclean surfaces.

The lower the surface tension, the more effectively a coating wets, levels and spreads. And no surfactant lowers surface tension more effectively than those made with fluorochemicals – like the next generation of 3M™ Novec™ Fluorosurfactants.

Novec fluorosurfactants are a family of advanced wetting and leveling agents, used in a broad range of aqueous and solvent-borne coatings. Based on innovative chemistry different from conventional fluorosurfactants, they offer formulators an outstanding level of performance and control:

**Improved wetting** – For a liquid to wet a surface, its surface tension must be lower than the surface energy of the substrate and all the contaminants on the substrate. Novec fluorosurfactants aid in the wetting of a coating applied to a variety of materials, including hard-to-wet surfaces such as plastics and oily metals. They can even help overcome contamination from roller grease, condensation drip, dust, gel particles or silicones. Lowering surface tension during application helps to prevent surface defects, including cratering, picture framing, fish eyes and de-wetting.

What’s more, Novec fluorosurfactants help to maintain low surface tension throughout the entire drying process. This helps to create smoother, higher gloss coatings. You can use Novec fluorosurfactants in many industrial and commercial coatings, including paints, resins, adhesives, inks, clearcoats, floor coverings and more!

**Better leveling** – When a liquid contains components of different surface tensions and areas of different evaporation rates, there is the possibility that surface tension gradients could form defects at the liquid/air interface. These defects are in the form of a surface roughness often referred to as “orange peel.” Novec fluorosurfactants improve leveling by reducing or even eliminating these gradients during the coating dry down phase—resulting in a smoother, more uniform surface.



### Fluorosurfactants vs. hydrocarbon and silicone surfactants

Based on an innovative fluorochemical building block, Novec fluorosurfactants are polymers that show the same performance benefits that have long differentiated fluorochemicals from competing surfactant technologies, such as silicones and hydrocarbons. 3M believes that this stems from the unique physical properties of the fluorochemical component of these materials.

With Novec fluorosurfactants very little product is necessary to achieve a significant surface tension reduction of a formulation, which for customers means low use levels. Hydrocarbons, in contrast, often require an order of magnitude more product to significantly reduce surface tensions, and

the surface tensions levels reached do not approach those possible with Novec fluorosurfactants.



Fluorinated Surfactant



Hydrocarbon Surfactant

Intercoat and second coat adhesion can often be adversely affected when using silicone or conventional fluorochemical surfactants. However, in formulations using Novec fluorosurfactants this problem has not been observed, even at higher loading levels.

Novec fluorosurfactants can reduce surface tension levels to about 20 dynes/cm in aqueous and non-aqueous systems surfactants. Hydrocarbon surfactants can reduce surface tensions to only about 30 dynes/cm, whereas silicone surfactants lower surface tensions to about 25 dynes/cm.

## Surface Tension Reduction Potential of 3M™ Novec™ Fluorosurfactants

The following table shows the surface tension reduction potential (in dynes/cm) of 3M™ Novec™ Fluorosurfactants FC-4430, FC-4432 and FC-4434 in some commonly available water-borne resins in comparison to competitive hydrocarbon and silicone surfactants.

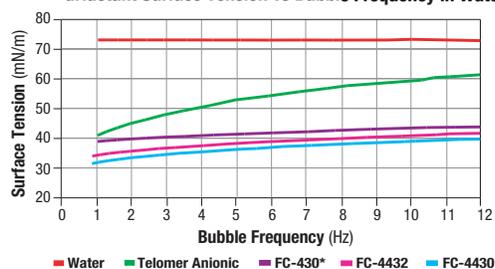
### Surface Tension/CMC (in water)

Resin	No Surfactant	HC Surfactants 1.00%	FC-4430 0.3%	FC-4432 0.3%	Competitive FC Surfactant 0.3%	Silicone Surfactant 0.5%
NeoCryl™ A-6099	39.1	29.0	24.3	20.1	26.1	27.3
NeoRez™ R-941	43.1	29.8	21.2	19.9	24.4	23.8
NeoRez™ R-9621	47.4	33.1	21.2	20.4	24.2	22.8
Joncryl® 537	37.4	31.8	19.7	21.0	25.6	27.6
Joncryl® 1532	38.4	32.9	21.2	23.4	26.9	28.9
Joncryl® 1925	41.0	31.2	19.7	20.2	25.4	27.1
Joncryl® 1972	38.9	27.6	22.4	21.9	26.3	27.6

## Low Dynamic Surface Tensions

Dynamic surface tension data describe the ability of a surfactant to move and organize in a solution. Low dynamic surface tensions or rapid surfactant migration can be important in high-speed coating processes or low viscosity systems. Novec fluorosurfactants can reduce dynamic surface tensions to lower levels than conventional fluorosurfactants (PFOS and telomer derived) as illustrated in this chart.

Fluorosurfactant Surface Tension vs Bubble Frequency in Water



\*FC-430 is no longer available for sale from 3M. Data related to FC-430 are presented here for historical reference purposes only.

## Low Interfacial Surface Tensions at Low Concentrations

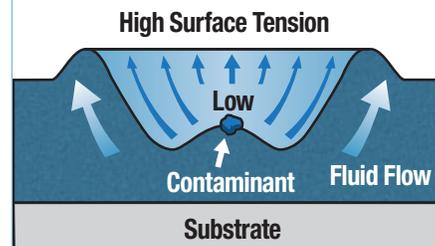
The ability to obtain lower interfacial surface tension is a key requirement for the stabilization of pigments and polymer resins in an aqueous formulation. Novec fluorosurfactants can provide low interfacial surface tensions as indicated by the following table.

Surfactant	Interfacial Tension Light Phase: Heptane (dynes/cm)			Interfacial Tension Light Phase: Cyclohexane (dynes/cm)		
	200ppm	0.5%	1.0%	200ppm	0.5%	1.0%
Control		43.7			51.2	
FC-4430	3.5	2.2		2.5	1.5	
FC-4432	4.2	2.6		4.2	2.1	
FC-430 <sup>1</sup>	3.5	2.4		4.0	2.1	
SDS <sup>2</sup>	15.4	6.1	5.8	12.9	5.0	4.9
SDS-10 <sup>3</sup>	15.9	4.1	3.7	13.5	2.9	2.6
Silicone Dispersant	14.4	10.9	10.5	11.7	8.8	8.8

<sup>1</sup>FC-430 is no longer available for sale from 3M. Data related to FC-430 are presented here for historical reference purposes only.

<sup>2</sup>Sodium dodecyl sulfate

<sup>3</sup>Sodium dodecyl benzene sulfonate



Contaminants can cause surface tension gradients, resulting in a "cratering" or "fish eye" effect. By reducing surface tension, Novec fluorosurfactants can significantly reduce or eliminate these surface defects.



### 3M™ Novec™ Fluorosurfactant Product Safety and Handling

3M™ Novec™ Fluorosurfactants FC-4430, FC-4432 and FC-4434 are intended for use in non-dispersive applications.

3M does not recommend these products for use in applications involving repeated exposure through skin contact, inhalation, or ingestion. They are not intended for food, cosmetic, medical or pharmaceutical usage. Neither 3M nor the U.S. Food and Drug Administration has evaluated or reviewed these products for food, cosmetic, medical or pharmaceutical applications.

It is the user's responsibility to determine whether a coating containing these products is durable and properly cured for the end use. Any used or unused material for disposal should be incinerated in an industrial or commercial facility in the presence of a combustible material. Combustion products will include HF. Facility must be capable of handling halogenated materials. As a disposal alternative, dispose of waste product in a facility permitted to accept chemical waste. For additional disposal information, see the product's Material Safety Data Sheet.

For additional product safety and handling information, please read the product labels and Material Safety Data Sheets before using these products.

### The 3M™ Novec™ Brand Family

The Novec brand is the hallmark for a variety of proprietary 3M products. Although each has its own unique formula and performance properties, all Novec products are designed in common to address the need for safe, effective, sustainable solutions in industry-specific applications. These include precision and electronics cleaning, heat transfer, fire protection, lubricant deposition and several specialty chemical applications.

3M™ Novec™ Electronic Surfactants • 3M™ Novec™ Engineered Fluids • 3M™ Novec™ Aerosol Cleaners • 3M™ Novec™ 1230 Fire Protection Fluid • 3M™ Novec™ Electronic Coatings

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