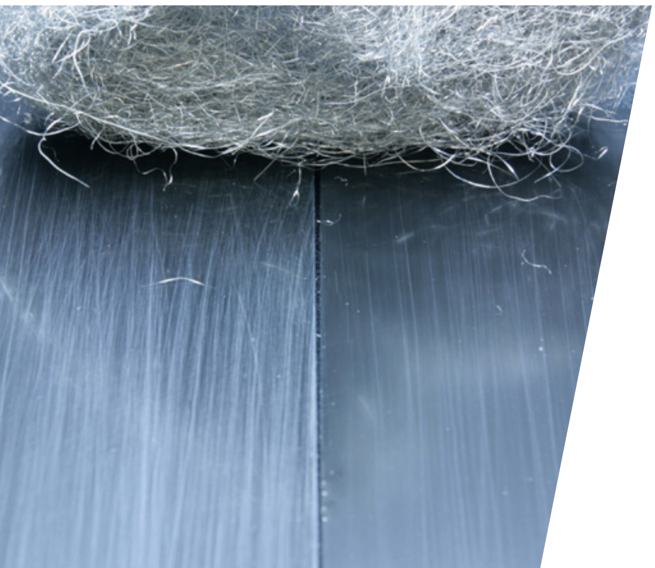
Alternatives to PTFE

The use of ultra-fine Polymethylurea as an alternative to PTFE fine powders and PTFE / wax mixtures.



Deuteron®
ADDITIVES TO YOUR SUCCESS

/ Additives based on polymethylurea

Halogen-free high-performance plastics with properties similar to PTFE

Nowadays, additives based on PTFE are state-of-the-art in many paint and printing ink applications. Especially due to the low coefficient of friction and the resulting properties, PTFE-containing additives are used to improve scratch and abrasion resistance.

Despite the technical advantages, the use of PTFE (and other halogenated materials) is not undoubted. The persistent character of this substance group is the major point of concern. This refers to the slow degradation rate of perfluorinated polymers and their ability to accumulate in the environment without being degraded. Currently, the focus is on perfluorooctanoic acid and its salts (PFOA and PFOS). The PTFE fine powders used in the paint industry are currently processed using depolymerization by gamma radiation to improve their grindability. During this irradiation, PFOA is formed as a by-product in significant concentrations.

To address this issue, EC 2017/1000 was adopted by the European Union in 2017. This regulation limits the PFOA concentration (as a collective term for all perfluorooctanoic acid derivatives) in many products to a maximum of 25 ppb as of July 2020.

Due to its unique properties it is not possible to replace PTFE in every application without further formulation adjustment. The main purpose of PTFE and PTFE modified waxes in coatings is to optimize scratch and abrasion resistance.

The good mechanical resistance of the modified coating films is achieved due to the extremely low coefficient of friction (COF). In addition, a PTFE particle can be „sheared“ comparatively easily under mechanical stress. The PTFE material rubbed off in this way is deposited on the coating like a sliding film and thus facilitates sliding of the rubbing foreign body.

/ Alternatives to PTFE in paint applications

With its polymethylurea chemistry (PMU), Deuteron offers an interesting, functional alternative to PTFE-based additives. PMU is an organic, halogen-free polymer with a high molecular weight and high crosslinking density. Polymethylureas are non-melting, extremely hard materials which also show a comparably low coefficient of friction.

As an additive in the coating film, PMU fine powders lead to significantly improved mechanical resistance and a significantly lower COF and are therefore excellently suited as functional replacements for PTFE-based additives.

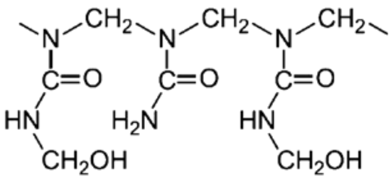
Deuteron offers two fine powders based on PMU chemistry under the product names Deuteron SF 505 and Deuteron SF 707.

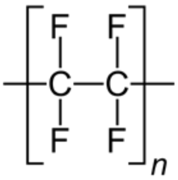
/ Advantages of Deuteron SF products

Polymethylurea in general is characterized by a high compatibility in almost all paint systems. The products are easy to disperse and can be processed without wetting agents. Due to their low density compared to PTFE, they are less prone to separation. Due to a refractive index close to the IOR of most coating resins, PMUs generally have a significantly lower tendency to film cloudiness / turbidity.

/ Comparison between PMU and PTFE

Physical data and general properties



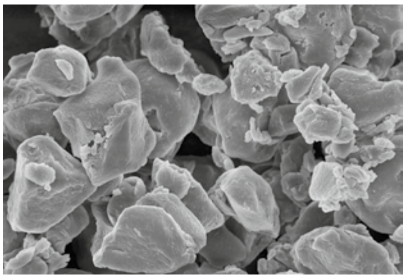


/ Deuteron SF Products

- Polymethylurea (halogen free)
- Density: 1.46 g/cm³
- Melting point: non-melting (duromer)
- Decomposition temperature: > 200°C
- Refractive index: 1,61
- Polar polymer (OH content: ~0.25%) - crosslinkable

- High hardness
- Low coefficient of friction
- Low haze
- Low gloss influence
- Economic material

Especially in the area of surface protection, PMU plastics achieve properties comparable to PTFE-based additives because of their high hardness.

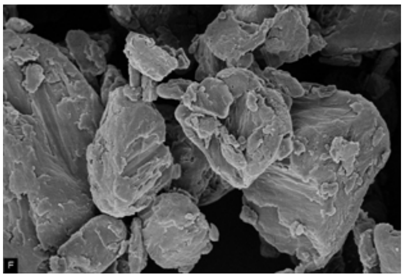


/ PTFE Powder

- Polytetrafluoroethylene
- Density: 2,20 g/cm³
- Melting point: not melting
- Decomposition temperature: > 345 °C
- Refractive index: 1,35
- Non-polar polymer (difficult to wet)

- Elastic
- Very low coefficient of friction
- Tendency to haze at higher addition rates
- Low gloss influence
- High-priced additive

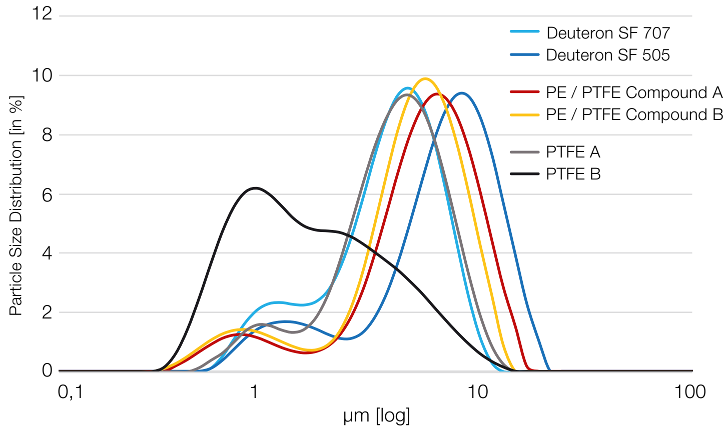
Standard additive for scratch and abrasion resistant systems. Versatile due to its unique properties.



/ Particle size of Deuteron SF products

The particle size has a considerable influence on the final properties of a system.
Basically, the coarser the additive, the greater the influence on gloss and haptics. However, a sufficiently large particle size is required for efficient surface protection. Here it is necessary to determine which particle size represents the best compromise between protection and other film properties by application testing.

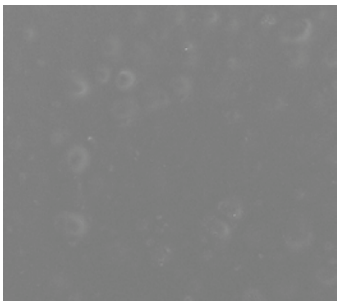
The graph on the right shows various PTFE-containing additives compared to Deuteron SF 505 and Deuteron SF 707. The two available particle sizes allow a wide coverage of different application areas.



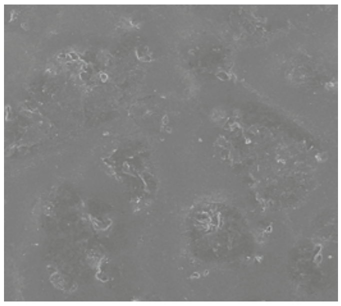
/ Compatibility in the coating

Due to its polar character, polymethylurea can be easily dispersed in most coating systems. Usually the embedding and anchoring in the binder matrix is usually excellent. This can be further improved by cross-linking the OH groups and thus increasing the mechanical resistance significantly.
Because of the good compatibility the recoatability of PMU containing coatings is usually very good.

The pictures on the right show the embedding of PMU particles and PE / PTFE particles in a classic, solvent-based 2k PU system. These are SEM images of the paint surface.



Deuteron SF 707
2% / 35 µm Dry film
Good embedding of the particles in the resin matrix

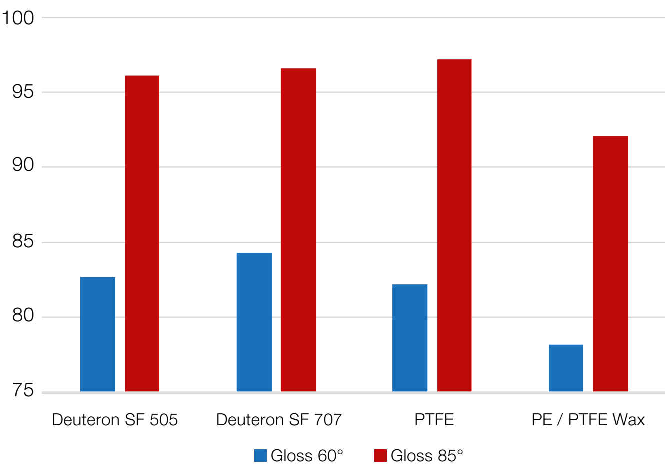


PE / PTFE Wachs
2% / 35 µm Dry film
Partially exposed particles, moderate embedding

/ Gloss retention

The gloss retention of fine PMU powders is comparable with the gloss retention of pure PTFE additives as well as with the effect of PE / PTFE wax combinations.
Due to the comparable particle morphology, the matting effect is primarily dependent on the ratio of particle size to dry film thickness.

When using Deuteron SF products, a comparable gloss to PTFE containing additives can be assumed at similar quantities.



/ Film Turbidity / Haze

Due to a refractive index of 1.61, which is close to that of many coating resins, PMU leads to rather low haze in many applications. This effect can have a positive influence on the appearance of the dry coating film, especially when working with higher addition levels.

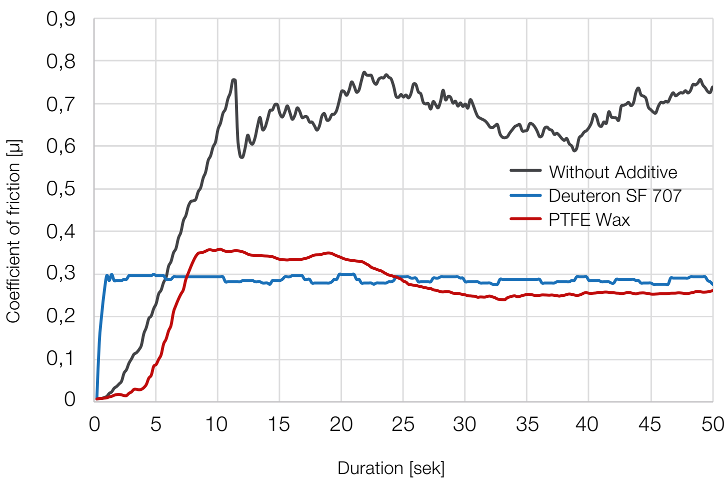
Refractive indices of common resins:

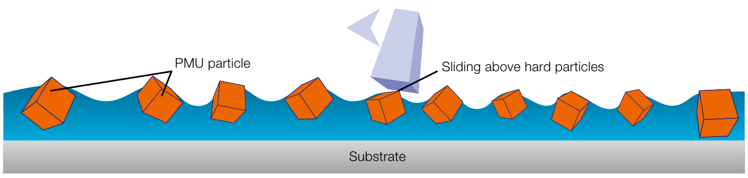
Acrylates:	~1.48 - 1.51
Styrene acrylates:	~1.51 - 1.56
Polyurethanes:	~1.49 - 1.56
Epoxides:	~1.51 - 1.59
Alkyds:	~1.61 - 1.63

Picture right: Comparison of the Haze in a solvent based 2k PU system with comparatively high additive loading.

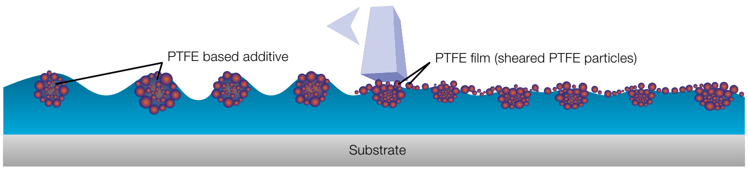
/ Coefficient of friction

A comparison of the coefficients of friction between PMU and PTFE shows a significantly reduced COF for both materials. Both materials lead to a quite similar COF reduction. It is worth mentioning that the COF reduction of Deuteron SF 707 takes place instantly and the curve just runs out. With PTFE-based additives a slightly increased COF can be seen at the beginning of the measurement. After approx. 15 seconds the formation of the PTFE sliding layer leads to a further reduction of the COF. This behaviour of a slightly higher COF at the beginning of the measurement is characteristic for PTFE-based additives.





The influence of PMU particles in schematic representation: The surface protection is primarily provided by the high hardness of the solid particles. In addition, the COF is reduced by protruding particles.



The influence of PTFE-based additives in schematic representation: The friction body produces a very thin PTFE sliding layer through abrasion on the PTFE. This layer acts like a “ball bearing” and reduces the COF.

Product	Particle size d50	d90	d99	Surface protection	Slip / COF
Deuteron SF 505	7	12	18	+++	+
Deuteron SF 707	4	8	12	++	+++
	µm	µm	µm		

/ Summary

Surface additives based on polymethylurea (PMU) represent an interesting alternative to replace expensive PTFE-containing products in many applications. Due to their high hardness and comparatively low COF, PMUs can completely or partially replace PTFE based additives in many coating applications.

Compared to PTFE-modified waxes a 1:1 replacement is usually possible. If pure PTFE is used, it is advisable to check a concentration series to determine the optimum quantity to be added.
In general, it is highly recommended to run laboratory tests to carefully determine the needed addition levels of PMU to achieve similar protection effects as with PTFE based materials.

Depending on the resins used, PMUs sometimes show lower film turbidity, are easier to disperse due to their polarity, are highly compatible in many systems and can be easily painted over.

Deuteron®
ADDITIVES TO YOUR SUCCESS

/ Visit us on the Internet

You can find detailed information on all our products at www.deuteron.com. Matting and texturing agents, surface additives, UV initiators and much, much more: We supply first-class products and look back on more than 30 years of experience as an important partner for the coatings industry.

DEUTERON GmbH
In den Ellern 2-4
28832 Achim / Germany

Phone +49 (0) 421 48 99 03-0
Fax +49 (0) 421 48 99 03-60

Mail contact@deuteron.com
URL www.deuteron.com