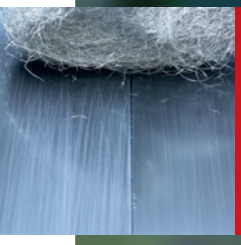


Alternatives to PTFE

The use of fine Polymethylureas as an alternative to PTFE fine powders and wax mixtures.

Deuteron®
ADDITIVES TO YOUR SUCCESS

Additives based on polymethylurea

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

Additives based on PTFE are widely used 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 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.

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 a wide range of different PMU-based additives with different morphology, particle sizes and supply forms.

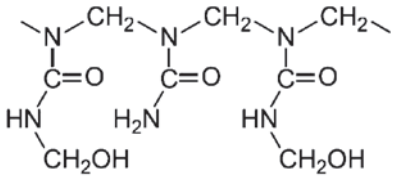
Advantages of Deuteron PMU products

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, PMU generally have a significantly lower tendency to film cloudiness / turbidity.

Comparison between PMU and PTFE

Physical data and general properties

Polymethylurea

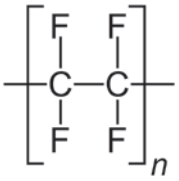


- Density: 1.46 g/cm³
- Melting point: non-melting (duromer)
- Decomposition temperature: > 200 °C
- Refractive index: 1.56
- Polar polymer (OH content: ~0.25 %) - crosslinkable

- 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.

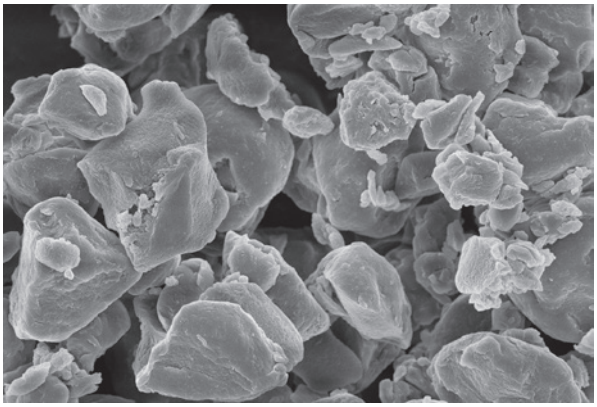
Polytetrafluorethylene

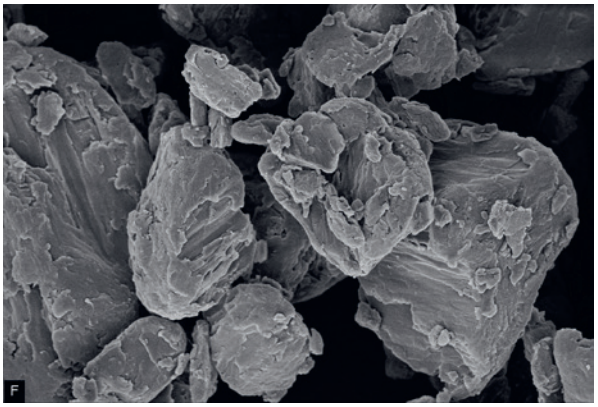


- Density: 2.20 g/cm³
- Melting point: not melting
- Decomposition temperature: > 345 °C
- Refractive index: 1.35
- Non-polar polymer (difficult to wet)

- 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.



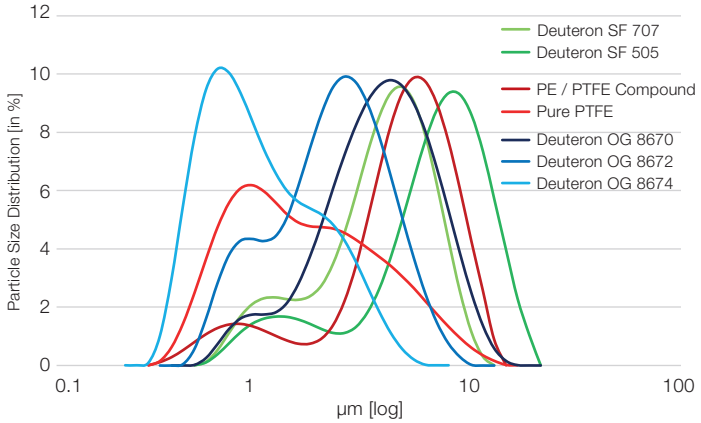


Particle size of Deuteron PMU products

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 gives an overview of the available particle sizes by comparing PTFE vs. two PMU powders and three liquid preparations.

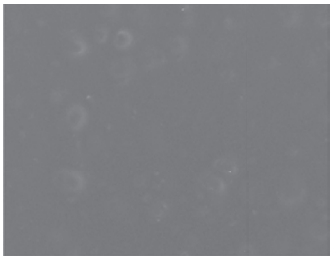


Compatibility in the coating

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.

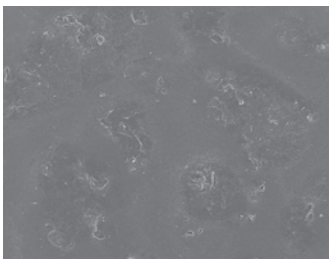
The pictures on the right show the embedding of PMU particles and PE / PTFE particles in a classic, solvent-based two-components PU system. These are SEM images of the paint surface



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

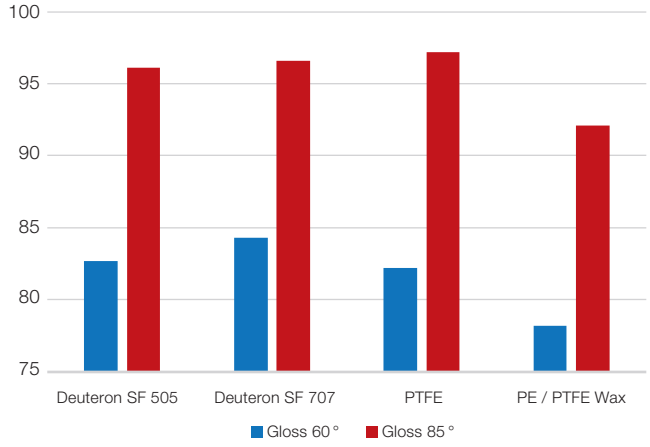
Partially exposed particles, moderate embedding

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 PMU products, a comparable gloss to PTFE containing additives can be assumed at similar quantities.



Film Turbidity / Haze

Due to a refractive index of 1.56, 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.

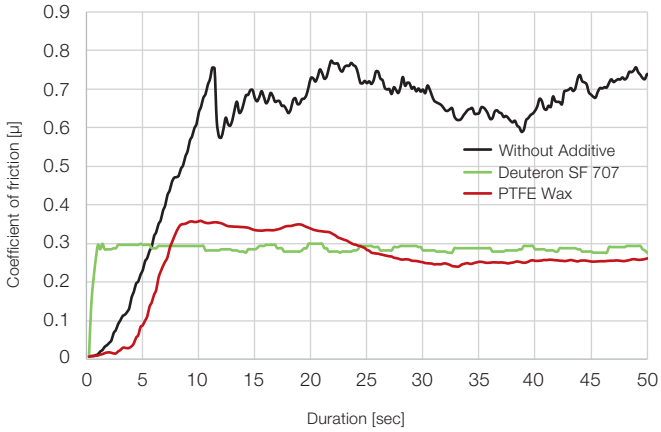
Refractive indices of common resins:

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

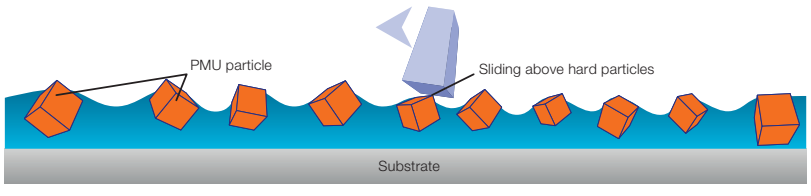
Picture right: Comparison of the Haze in a solvent based two-components PU System with comparatively high additive loading.

Coefficient of friction

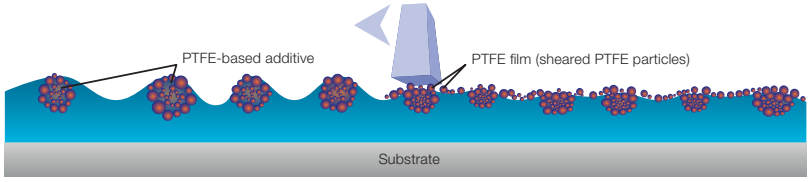
A comparison of the coefficients of friction between PMU and PTFE shows a significantly reduced COF for both materials. Both materials lead to a quite similar COF reduction. It is worth mentioning that the COF reduction of Deuteron SF 707 takes place instantly and the curve just runs out. With PTFE-based 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.



Additives based on polymethylurea

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

	Supplyform	Solvent	Particle Size µm			Gloss retention	Protection	Slip
			d50	d90	d99		*mechanical*	
Deuteron SF 505	Powder	-	7	12	18	●	●●●	●
Deuteron SF 707	Powder	-	4	8	12	●●●	●●	●●●
Deuteron OG 861	Suspension	Solvesso 150 ND	3.5	7	12	●●	●	●●
Deuteron OG 863	Suspension	Isopropylalcohol	3.5	7.5	12.5	●●	●	●●
Deuteron OG 8670	Suspension	Water	3.5	7.5	12.5	●●	●	●●
Deuteron OG 8803	Suspension	DPGDA	3.5	7	12	●●	●	●●

● low influence ●● medium influence ●●● strong influence

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, PMU 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

Deuteron: First-class products for the coating industry

Deuteron successfully develops and sells innovative additives since 1977. Our product range consists of matting agents, anti-static additives, texturing additives, thickeners and UV initiators. In the course of our company history we have become an important partner of the national and international paint, lacquer and coating industry with sales agencies around the globe.

Visit us on the Internet

Our documents such as product datasheets, safety datasheets, regulatory information and brochures are available in the download area of our website without registration.

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