CASE STUDY

A superior and safer alternative to PTFE for use as a friction reducing additive in coatings

Summary

Product type: Abrasion Resistance Agents
Application: Coatings
Key benefits: Enhanced abrasion resistance | Improved chemical resistance| Improved self-lubrication

The Challenge

Polytetrafluoroethylene (PTFE) has been widely used in coatings for reducing friction and increasing abrasion resistance. Perfluorooctanoic acid (PFOA) is a chemical used in the production of PTFE. Studies have shown a significant correlation between high exposure to PFOA and serious health issues including kidney and testicular cancer, thyroid disease, high cholesterol, and pregnancy-induced hypertension. In May 2019, the UN's Stockholm Convention on persistent organic pollutants agreed to a global ban on PFOA and related compounds. The EU is a party to the Convention and must incorporate the decision in its regulations. The increasing regulation and awareness regarding PFOA as a potential carcinogen, health hazard and a persistent environmental contaminant is causing formulators to look for a suitable alternative to PTFE.

The Solution

Mitsui Chemicals' MIPELON™ ultra-high molecular weight polyethylene (UHMW-PE) is a very fine polyethylene powder. The spherical particles of MIPELON™ enhance the abrasion resistance and lubricity when used as an additive in coatings. Additionally, MIPELON™ is safe and environment friendly. The MIPELON™ range of UHMW-PEs presents high-performance alternatives to the use of PTFE in coatings. MIPELON™ UHMW-PE has spherical particles with a narrow particle size distribution.

MIPELON™ XM220 has an average diameter of 30um while MIPELON™ PM200 has an average particle diameter of 10um.

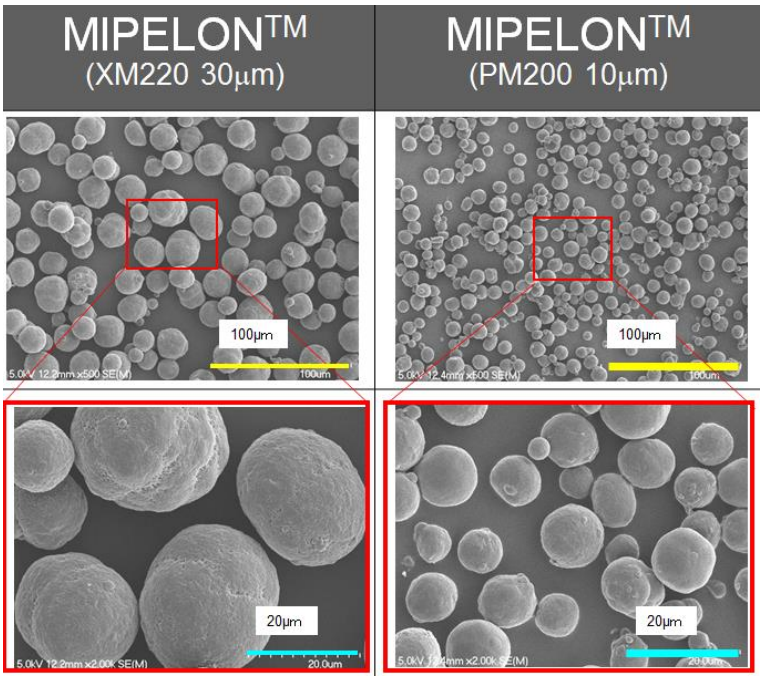

Figure 1: MIPELON™ has spherical particles with a narrow particle size distribution

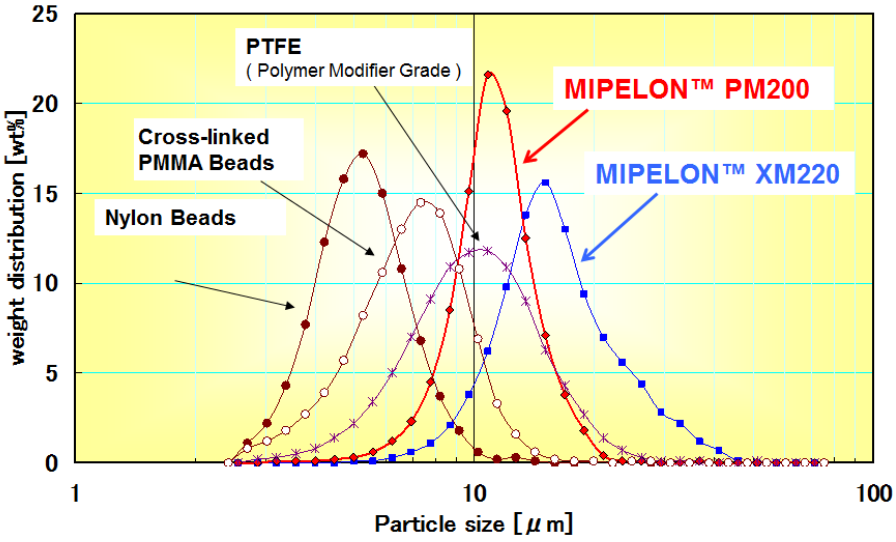

Figure 2: Particle size distribution of various organic beads used as additives in coatings

MIPELON™XM220 and PM200 have an average particle size in the same range as other organic beads used as polymer modifiers, such as PTFE, PMMA and Nylon but with a narrower particle size distribution. Addition of MIPELON™ to paints and coatings imparts the following properties:

1 - Superior Abrasion Resistance and Low Friction Coefficient

MIPELON™ reduces friction and increases abrasion resistance when used as an additive in coatings. Tests were conducted to compare the performance of MIPELON™ with other organic beads used as additives for reducing friction and abrasion in coatings. An SUS board was pulled horizontally on a dry powder sample of the additive. Figure 3 shows the particle size and coefficient of friction for each type of powder tested.

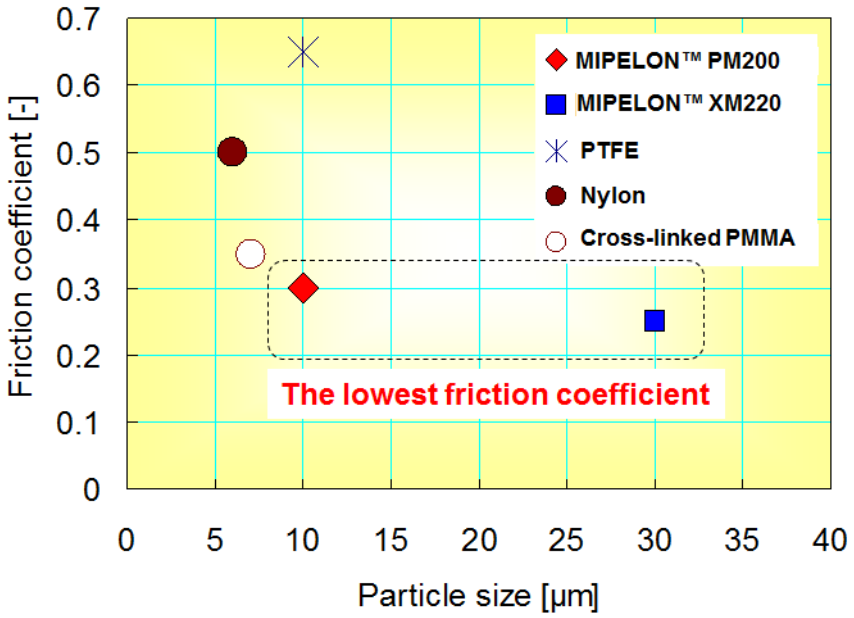

Figure 3: Comparison of particle size and coefficient of friction between an SUS board and various additives in dry powder form

MIPELON™ XM220 shows the lowest coefficient of friction followed by MIPELON™ PM200 while PTFE shows the highest coefficient of friction among the materials tested.

To further test and compare the performance of MIPELON™, as an additive in coatings, an EPDM sheet was coated with a standard primer. The sheet was then coated with a water-based PU paint to which 10% of a friction-reducing additive was added along with a compatible dispersant. The coefficient of friction, with glass, of the coated rubber sheet was measured. Figure 4 shows the change in coefficient of friction with the number of reciprocations for various additives. PTFE and PE Wax show a low initial coefficient which quickly increases and exhibits large variations over the duration of the test. PA12 shows a comparatively lower coefficient of friction which varies in a narrow band over 5,000 reciprocations. The lowest coefficient of friction is, however, shown by MIPELON™ PM200 over the duration of the test. The friction initially decreases with the number of reciprocations and then stabilizes to a low value. The results confirm that MIPELON™ improves the slipperiness of rubber more than PTFE, PA and PE wax and exhibits better durability as compared to PE wax and PTFE.

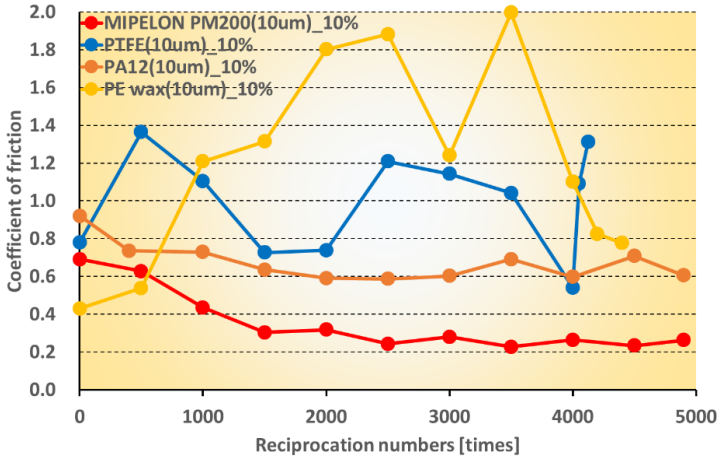

Figure 4: Variation of the coefficient of friction with reciprocations between coated EPDM sheets containing various additives

A similar test was conducted to compare the coefficient of kinetic friction, with glass, of EPDM sheet coated with MIPELON™ and PTFE as friction reducing additives. The coating containing PTFE shows a higher coefficient than MIPELON™ XM220. The PTFE coating peels off after approximately 18,000 reciprocations while MIPELON™ shows extended durability.

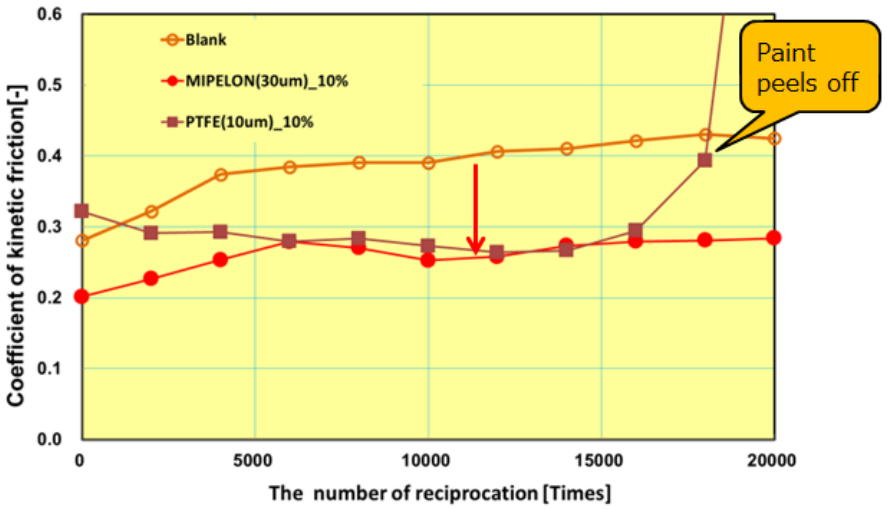

Figure 5: Variation of the coefficient of kinetic friction with reciprocations between coated EPDM sheets containing MIPELON™ and PTFE as additives

The superior performance of MIPELON™, as a friction reducing additive, is based on the spherical shape and smooth surface of MIPELON™ particles and better abrasion resistance of the UHMW-PE material. The particles retain their spherical form even after repeated use keeping the contact area with glass to a minimum. The abrasion resistance thus leads to lower friction and greater durability. PTFE particles have a rough surface which is abraded as the particles slide against another surface. The abrasion increases the contact area which leads to an increase in the coefficient of friction. Figure 6 illustrates how superior abrasion resistance of MIPELON™ also makes it a better friction reducing additive.

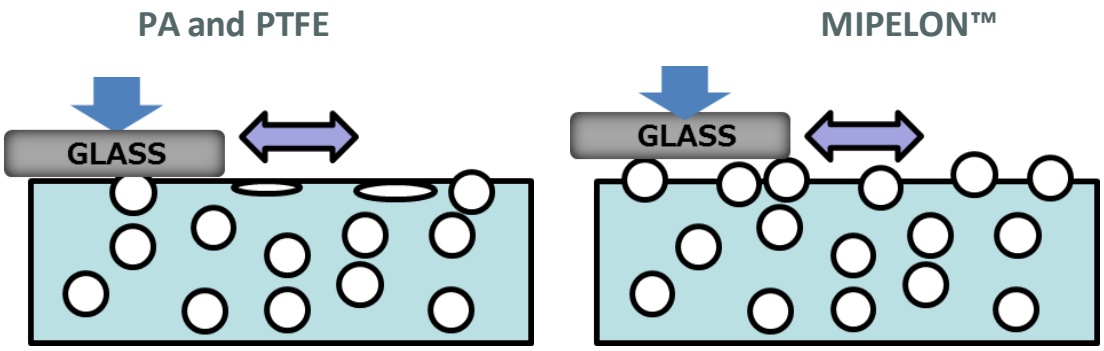

Figure 6: Abrasion causes contact area with glass to increase leading to increased friction

Good abrasion resistance keeps contact area small resulting in a smaller coefficient of friction.

2 - Excellent Matting Performance

In addition to improving abrasion resistance and slipperiness, MIPELON™ also provides a matting effect, even when added in small amounts to coatings. Figure 7 compares the gloss of coatings containing 25% by weight of PTFE and 25% MIPELON™. The coating containing MIPELON shows a much greater reduction in gloss as compared to PTFE. Addition of only 11% of MIPELON™ produces approximately the same gloss reduction as 25% PTFE.

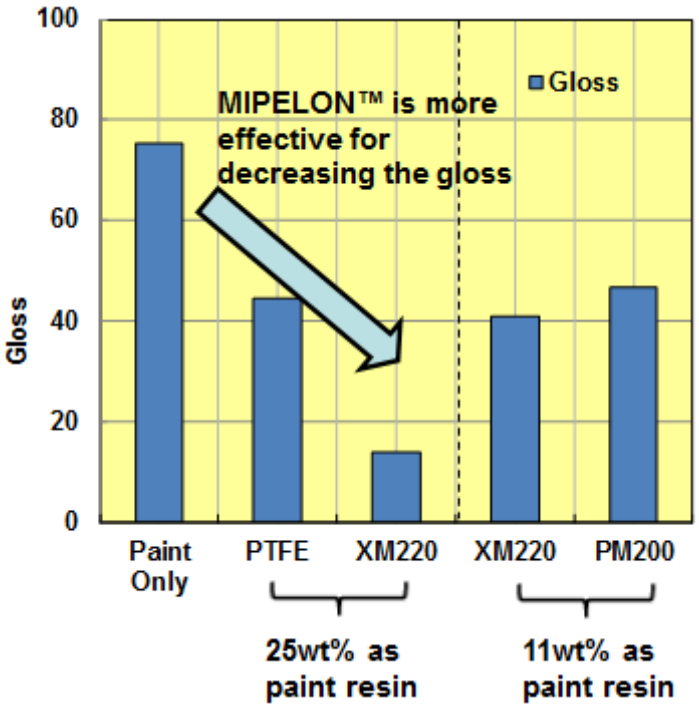

Figure 7: MIPELON™ has a higher matting effect as compared to PTFE

3 - Better Dispersibility

Another problem associated with the use of PTFE in coatings is dispersibility. PTFE has a high specific gravity which causes it to settle out at the bottom. MIPELON™ is light weight and shows better dispersibility in coatings. A lab test was conducted to compare the stability of dispersions of PTFE and MIPELON™ in polyurethane paints. Results presented in Figure 8 show that MIPELON™ stays dispersed in PU paint even after 72 hours of dispersing action whereas PTFE begins to settle out after just 24 hours.

	MIPELON™ PM-200	MIPELON™ XM-220	PTFE
24 Hours			
72 Hours			
	Figure 8: Static standing test tube after blending various resins and polyurethane paint.		

Conclusion

MIPELON™ is a superior alternative to PTFE for improving the abrasion resistance, and reducing friction of resins, rubbers, greases, paints and other coatings. It imparts high durability to the coating due to its ultra-high molecular weight and spherical particles. MIPELON™ performs better in reducing the coefficient of friction of coatings as compared to PTFE. With a suitable dispersant, MIPELON™ is easily dispersible in water and solvent based polyurethane paints commonly used to improve the abrasion resistance of EPDM. MIPELON™ exhibits good matting properties and addition of a small amount leads to significant reduction in coating gloss. As health and environmental concerns surrounding the use of PTFE increase, prompting new regulations, MIPELON™ offers an attractive alternative to coating formulators.

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