

WHITE PAPER

Fine Silica Microspheres Offer Safe Alternative for Plastic Microbeads in Skincare Formulations

April 2023



For the past 50 years, microplastics have been a widely used ingredient of personal care and cosmetic products (PCCPs). These small polyethylene plastic particles, with a size of under 200 um, are used as exfoliants and additives in products like cleansers, sunscreens, body scrubs, toothpaste and more. And we all know that most cosmetics use microplastic with much smaller particle sizes than this upper limit. According to a 2022 report by the [Plastic Soup Foundation](#), 90% of products from top cosmetic brands contain microplastics.

Documented Dangers of Microbeads

Although primary microplastics used in cosmetics account for a small portion of global microplastic pollution, they pose a threat to the environment when released into household sewage. Due to their tiny size, wastewater treatment plants only partially filter them, allowing many to enter waterways.

Microplastics can harm marine life when ingested because they are not biodegradable and can bind with chemicals. Consequently, they may enter our food chain. Recent research has discovered microplastics in humans for the first time, but their effects remain unknown.

Regulations for Microbeads

In 2015, Congress passed the Microbead-Free Waters Act of 2015, prohibiting the use of plastic microbeads in rinse-off cosmetics like shower gels and toothpaste. However, the legislation does not address other microplastics in personal care products or leave-on items such as lipstick, makeup, and deodorants that aren't typically rinsed off.

Countries like England, France and Canada have also banned microbeads. As global regulations aim to limit synthetic polymers in PCCPs, many eco-friendly manufacturers are voluntarily incorporating biodegradable microbeads in their products. The shift away from harmful plastics involves finding alternative ingredients that are environmentally safe.



Selecting Safe Alternatives

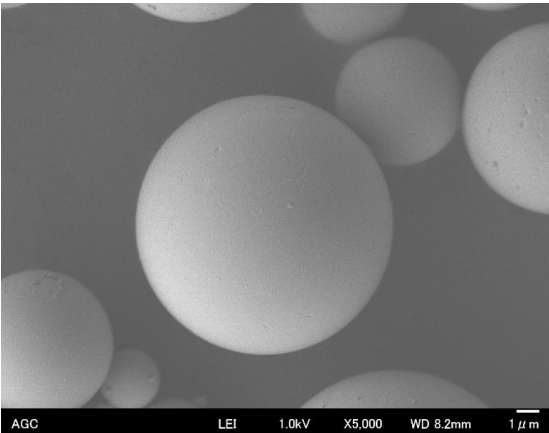
Finding the right replacement is complicated to maintain consistency in products. Cosmetic companies want to maintain properties such as smoothness and fluidity that are typically associated with PMMA (polymethyl methacrylate) and nylon powders while using eco-friendly ingredients.

Some potential replacements for [plastic microbeads](#) include acrylic acid copolymers and silicone oils, but they are not biodegradable and pose potential harm to the environment and aquatic life.

Sustainable and User-Friendly Ingredients

RESIFA™ SOLESPHERE™ fine silica microspheres offer an excellent alternative to red-flagged microplastic ingredients like Nylon 12 and porous PMMA in skincare and cosmetics. The particles are made from silicon dioxide, a natural and sustainable material. They are environmentally friendly and free from petroleum and plastic. They also boast Ecocert and COSMOS certifications for safety and sustainability, along with KOSHER and ISO 9001 certifications.

Unlike plastic microbeads that can deform under pressure, SOLESPHERE silica microspheres maintain their shape, ensuring the quality of cosmetic products. The near-perfect spherical shape creates a “slip” effect, resulting in a silky, smooth texture that’s easy to spread. These microspherical silicas also equal or exceed the smoothness, softness and the moisturizing feeling provided by microplastic beads in cosmetic products (refer to Chart A).



RESIFA™ SOLESPHERE™ fine silica microspheres are environmentally-friendly replacements to microplastics in the formulation of sunscreens, skincare, makeup, lipstick, mascara, facial cleansers and body washes.

Silica spheres are suitable for oil-in-water (O/W), water-in-oil (W/O) and anhydrous formulations. They enhance UV protection, reduce greasiness and stickiness, minimize pores and absorb oil and sweat. In addition, formulations incorporating RESIFA SOLESPHERE silica spheres leave skin feeling moisturized, smooth and radiant.

FEELING IS PARAMOUNT								
	MICROPLASTIC BEADS					SOLESPHERE		
Feeling	PMMA (porous)	PMMA (non-porous)	Silicone	Urethane	Nylon	Porous	Non-porous	Surface treated
Smooth	★★★★	★★	★★★★	★★★★	★★	★★★★	★★	★★
Soft	★	★★	★★	★★	★★★★	★	★★	★★★★

★: Average, ★★: Good, ★★★★: Best

Chart A: Different grades of RESIFA™ SOLESPHERE™ can match or surpass the “feeling” properties of microplastic beads for cosmetic products.

Safe UV Protection

SOLESPHERE silicas provide an SPF boost in formulations using inorganic (mineral) or organic (chemical) sunscreen actives. In addition, the silicas also improve the spreadability and texture of the formulation. These silicas are excellent in both O/W and W/O formulations, and can make a W/O formulation feel like an O/W formulation.

While SOLESPHERE microsphere particles don't provide sun protection themselves, their larger size compared to other SPF-boosting additives like microbeads enables them to form a thick, uniform film on the skin. This improves the dispersion of mineral actives throughout the film without feeling thick, heavy or pasty.

These SPF enhancers also scatter light so that when UV light passes through the film of a product on the skin, the porosity of the silica gels causes it to scatter in different directions. Many daily wear products including moisturizers and foundation also contain sunscreen actives to provide SPF protection.

Gentle Exfoliation

Certain silica microsphere grades effectively exfoliate and remove dirt when added to formulations for body and facial washes. The silica scrubs work as effectively as plastic beads, but are gentler due to their near-perfect spherical shape.

When rinsed off, they pose no threat to the environment, marine life or human health. Additionally, these particles can absorb fragrances for gradual release, further enhancing product formulations. SOLESPHERE silica properties that enhance exfoliation include:

- Hard particles for scrub: particles do not break
- Spherical particles: gentle to skin
- Low collapsibility: long-lasting scrubbing
- Silica 100%: environmentally friendly
- Stability: stable in formulation

INCI NAME	Silica
CAS NO.	7631-86-9
EINECS NO.	231-545-4
SHAPE	Spherical powder
FORM	Amorphous (Non crystalized)
COLOR	White
COMPONENT	Silica 100%



Oil Absorption

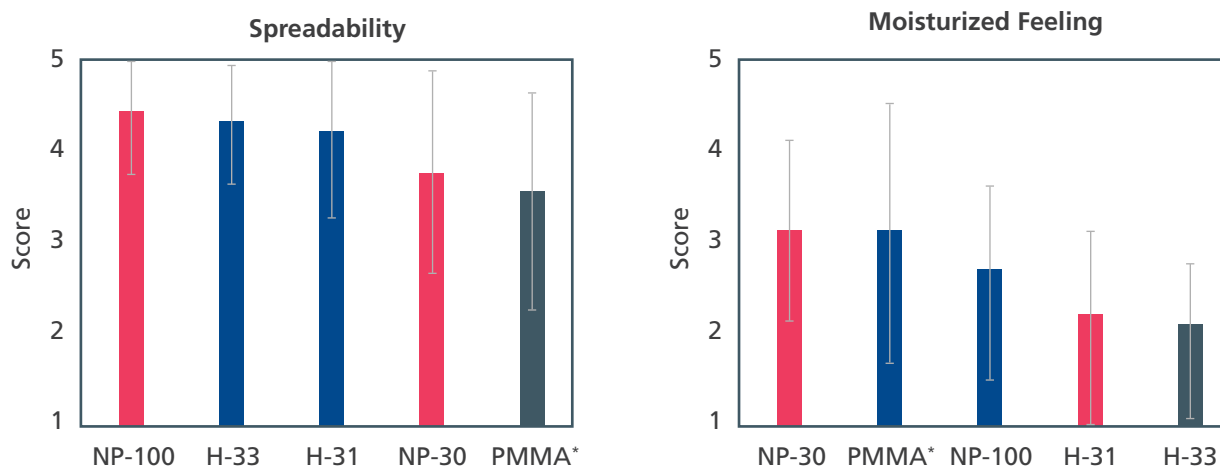
When used in formulations for oil absorption, tests show that nonporous grades of SOLESPHERE silica have an oil absorption capacity that is similar to plastic microbeads. They also improve slipperiness and smoothness at a level that is equal to plastic microbeads. If oil absorption is desired, several SOLESPHERE grades provide that along with equal or better aesthetics.



Improved Aesthetics

Besides enhancing SPF, the molecular composition of silica microspheres improves the quality and visual appeal of sunscreen formulas and other cosmetic products. When incorporated into inorganic sunscreen formulations with titanium dioxide and zinc oxide, silicas help reduce the white cast while promoting absorption for a silky-smooth feel. Adding a small amount of silica gel technology to W/O formulations can significantly improve aesthetics while boosting SPF.

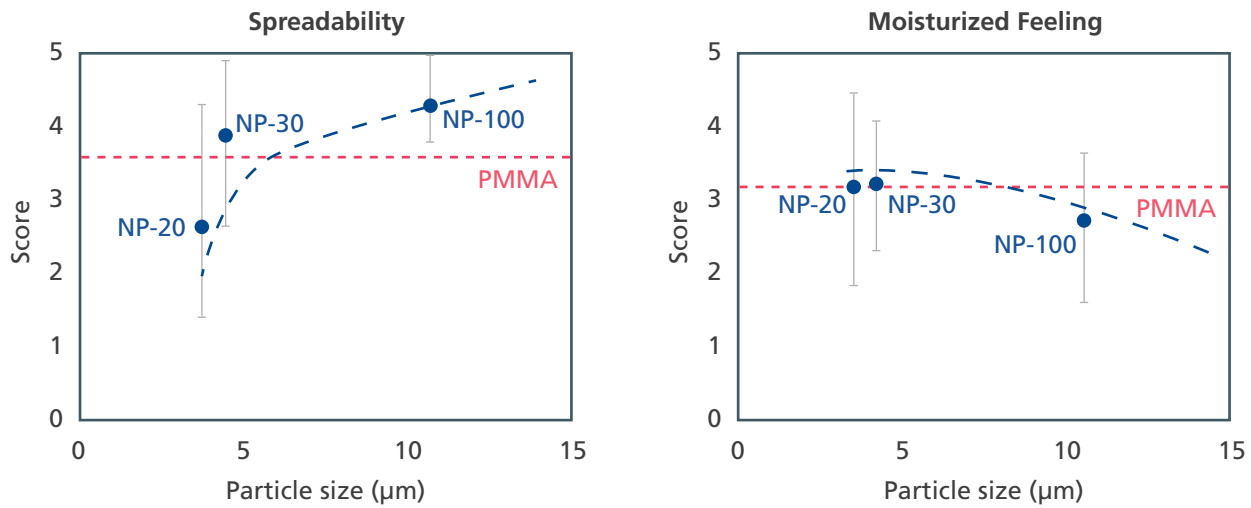
Microsphere particles resist deformation while maintaining product stability and consistency. The porosity of the spherical silica gels provides a soft-focus matte effect that blurs the appearance of wrinkles, producing an antiaging effect for tinted moisturizers and makeup foundations. The particles also capture sebum and oil in their pores, which prevents shine and makeup breakdown.



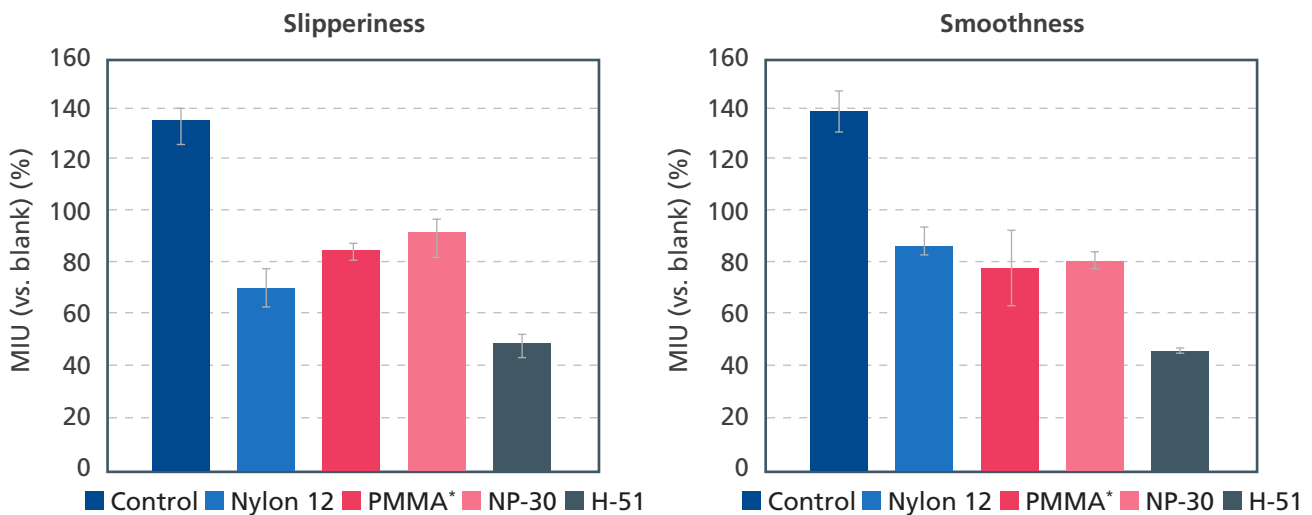
*non-porous

- Evaluation method: 5 scores, Subjects n=1
- Condition: sample 20µl approx. inner part of forearm 50cm²

The bigger the particle size, the more spreadable it is, but the less moisturizing it feels.



When testing for smooth feeling and spreadability using a friction tester on artificial leather, non-porous silica spheres are as effective as PMMA in skincare formulations.



*non-porous
Conditions

- Friction sensor: Artificial leather (Supplale, Idemitsu Technofine Co., Ltd.), Speed: 1mm/sec, Load: 25 g
Friction sensitivity: High, Sample Amount: 2.0 mg/cm², Substrate: Artificial leather

Soft Focus Effect

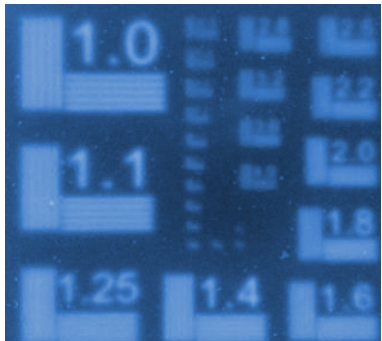
The SOLESPHERE portfolio can provide various degrees of soft focus and is comparable to PMMA. This allows the formulator to select the desired soft focus effect.



PMMA



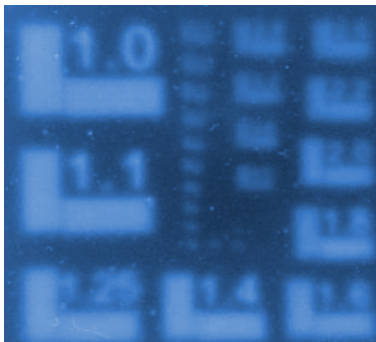
NP-30



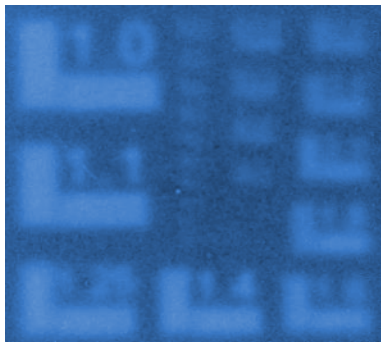
L-51



NP-100



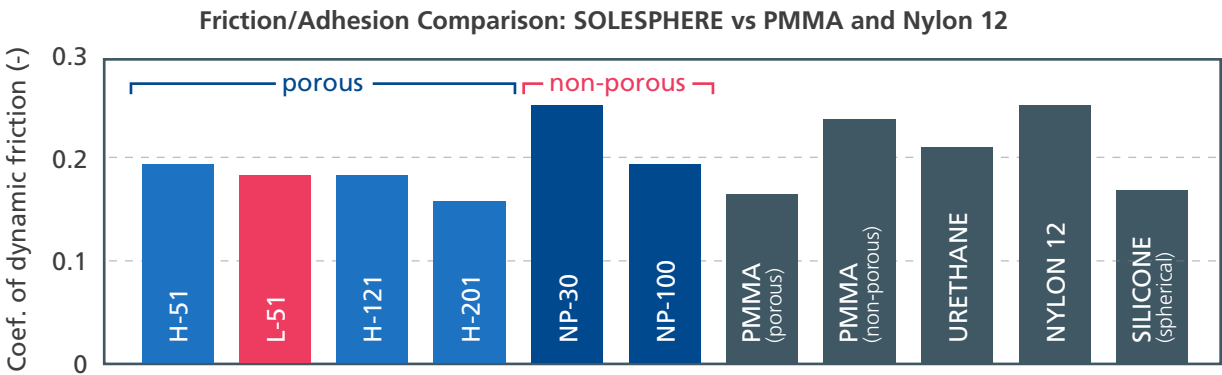
H-53



H-121

Friction/Adhesion

SOLESPHERE silica provides similar friction/adhesion performance compared to microplastics.



Conditions

- Friction sensor: TL-201Tt (Trinity-Lab, Inc.), Substrate: Artificial leather (Protein leather, IDEATEX JAPAN Co., LTD.), Sensor: HUMAN Model, Speed: 10mm/sec, Load: 30g, Sample amount: 0.08ml/100cm²

Grades for Specific Formulation Needs

SOLESPHERE silica gels are offered in particle sizes ranging from 3 to 300 μm and porous and nonporous grades. The table below shows the many grades and particle characteristics.

GRADE		MEAN PARTICLE SIZE (μm)	SPECIFIC SURFACE AREA (m^2/g)	PORE VOLUME (mL/g)	PORE DIAMETER (nm)	OIL ABSORPTION ($\text{mL}/100\text{g}$)
H-Series Normal Type	H-31	3	800	1	5	150
	H-51	5	800	1	5	150
	H-121	12	800	1	5	150
	H-201	20	800	1	5	150
H-Series High Absorption Type	H-52	5	700	2	10	300
	H-122	12	700	2	10	300
	H-33	3	700	2	11	400
	H-53	5	700	2	11	400
L-Series (porous)	L-31	3	300	1	13	150
	L-51	5	300	1	13	150
NP Series (non-porous)	NP-30	4	40	0.05	-	30
	NP-100	10	50	0.1	-	35
	NP-200	20	100	0.1	-	40

Cosmetic companies can select a specific grade of silica microspheres to achieve the desired combination of performance qualities in their formulations. For instance, in O/W formulations, H-33 reduces sliminess and blurring, while H-51 minimizes pores and blurring (with larger particle sizes resulting in greater blur effects and absorption). In W/O formulations, H-33 enhances SPF while decreasing sliminess and greasiness. For anhydrous formulations, H-51 improves skin hydration and smoothness.

Cosmetic companies can add multiple SOLESPHERE products to formulations. Although nonporous silica gels don't scatter light and therefore can't boost SPF on their own, they can be combined with porous SOLESPHERE silica to further increase SPF effectiveness.

Microspheres Enhance Variety of Products

- Sunscreen
- Skincare
- Lipsticks
- Mascara
- Body washes and scrubs
- Cream cleansers
- Deodorant



Product Grades for Different Skincare and Cosmetic Applications

TARGET	AIM	EFFECT	APPLICABLE GRADES
Skin care/Foundation	Texture improvement	Slippery	H-121, H-33, H-51
		Smoothness	H-121, H-33, H-51, NP-30
		Transparency	NP-30, NP-100
		Matte effect (Foundation)	H-121
	Sweat & sebum absorption	Long lasting effect	H-121, H-51, H-33
		Anti-oily feeling	H-53, H-52
	Coverage of wrinkle	Soft focus	H-121, H-33, H-51
	Defined features	Stereoscopic effect	H-121, H-51
Lip stick	Sweat & sebum absorption	Long lasting effect	H-121, H-33, H-53
	Rehology control	Solidifying agent	H-33, H-52, H-53
Mascara	Volume up	Bulking agent	H-121, NP-200
Sunscreens	SPF boost & sweat absorption	SPF boost	H-53, H-52, H-33
		Long lasting effect	H-53, H-52, H-33
Body washes	Texture improvement	Smoothness	H-121, H-33, H-51
		Long lasting effect	H-121, NP-30, NP-100
Deodorant	Sweat absorption	Long lasting effect	H-33, NP-30
		Solidifying agent	H-33, NP-30
Cream cleansers	Texture improvement	Slippery	H-121, H-33, H-51, H-53
		Smoothness	H-121, H-33, H-51
Body scrubs	Texture improvement	Exfoliation	D-200L

Concluding Thoughts

Though microplastics have been widely used in personal care and cosmetic products for the past 50 years, they pose environmental threats. RESIFA SOLESPHERE particles, made from silicon dioxide, maintain the quality of cosmetic products and provide additional benefits such as SPF enhancement, exfoliation and improved aesthetics. With various grades available, cosmetic companies can tailor their formulations for desired performance qualities.

Cosmetic manufacturers at the forefront of using biodegradable ingredients can benefit from the properties of fine silica microspheres while making manufacturing processes safer and more eco-friendly.

For more information about RESIFA SOLESPHERE silica or to submit a product inquiry or sample request, visit www.resifasolesphere.com or call 1-800-424-7833.

To learn more visit www.ResifaSolesphere.com
or contact an AGC product expert at 800-424-7833.

AGC's RESIFA™ SOLESPHERE™ product line is a series of revolutionary spherical silicas that vastly improve any personal care product to which they are added. Made from silicon dioxide, a natural and sustainable material, RESIFA™ SOLESPHERE™ gels are Ecocert- and COSMOS-certified for safety and sustainability.



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