

# A clear advantage

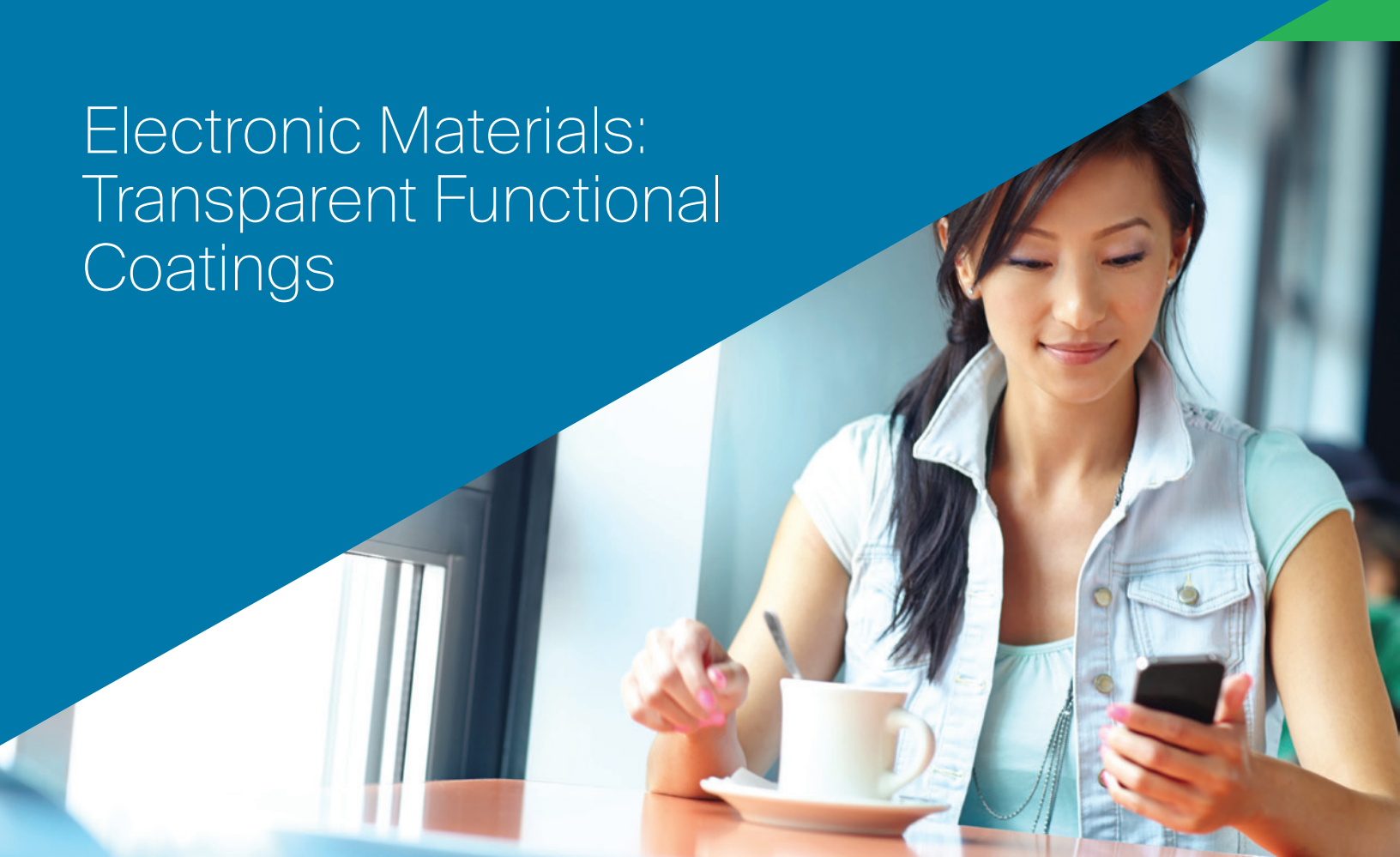


## Electronic Materials: Transparent Functional Coatings



We protect and beautify the world™

# Electronic Materials: Transparent Functional Coatings



## **Bringing clear benefits to the consumer electronics industry**

In the fiercely competitive world of consumer electronics, where shoppers can view competing products side-by-side, the ability to make one display screen look better than another can make the difference between closing a sale and losing one.

That's why – whether your product is a tablet, smartphone, computer or television – it pays to finish your display screens with transparent functional coatings from PPG. Our products include easy-to-clean (EC) / anti-smudge, anti-fingerprint (AFP) and anti-glare (AG) coatings, and we have the capability to combine these technologies into a complete pre-engineered, pre-stacked and pre-packaged transparent functional coatings solution.







## Proven technologies from a global coatings leader

As one of the world's leading coatings companies, PPG has broad expertise formulating durable, decorative and protective performance coatings for items as far ranging as optical glass, appliances, airplanes, automobiles, bridges and buildings.

For consumer electronics manufacturers, that expertise translates into industry-leading transparent functional coatings and a broad range of complementary electronic materials coatings that also include anti-reflection coatings; anti-moisture coatings; hard coatings; conductive coatings; conductive, resistive and dielectric inks; and so much more. With manufacturing facilities around the world, we provide complete, integrated solutions and are one of the few companies who can serve as a single-source coatings supplier to the consumer electronics industry.

## Collaborative product development

PPG operates multiple global research and development centers – including many in Asia – and has worked closely for decades with consumer electronics manufacturers to develop innovative coatings for plastic, metal, glass and composite substrates.

Because of our enduring relationships with numerous global manufacturers, PPG coatings are trusted to protect, beautify and enhance the surfaces of the world's most popular electronic devices.

## Easy-to-Clean (EC) / Anti-Smudge Coatings for Glass and Plastic

Available in various formulations, PPG EC coatings are sprayable, hydrophobic (water-resistant) and oleophobic (oil-resistant) coatings that help minimize smudging on touchscreens. They are the EC coatings of choice for several of the world's top OEMs because of their smudge-control capabilities as well as their exceptional durability and low coefficient of friction that provide a wonderful consumer experience and a silky touch-feel. The coatings are offered for spray or vapor deposition processes, and for glass and plastic substrates.

### Product Features

- Excellent smudge control
- Excellent abrasion resistance
- Silky touch-feel
- High light transmission

### Design/Process Benefits

- Sprayable
- Compatible with other PPG transparent functional coatings



Performance Properties	Test Method	On Glass				On Plastic	
		EC300X	EC600X	EC203	EC200	ECP200 / ECP203	ECP300
<b>Suggested Application Process</b>	-	Dry application		Wet spray		Wet spray	
<b>Initial DI Water Contact Angle</b>	ASTM D724	115-118°	115-118°	115-118°	115-118°	> 105°	> 105°
<b>n-Tetradecane Angle</b>	ASTM D724	67°	67°	67°	67°	N/A	N/A
<b>Transmission</b>	ASTM D1003	92.1%	92.1%	92.1%	92.1%	PC > 89%	PC > 89%
						PMMA, PET > 90%	PMMA, PET > 90%
						TAC > 91%	TAC > 91%
<b>Coefficient of Friction</b>	ASTM 1894	0.025	0.025	0.025	0.025	0.03	0.03
<b>Abrasion Resistance</b>	BONSTAR™ steel wool 0000	12,000 <sup>1</sup> cycles	20,000 <sup>1</sup> cycles	6,000 <sup>1</sup> cycles	20,000 <sup>1</sup> cycles	2,000 <sup>2</sup> cycles	2,500 <sup>3</sup> cycles
	MINOAN™ MUNBANGSAWOO™ eraser <sup>4</sup>	3,000 cycles	5,000 cycles	2,000 cycles	5,000 cycles	N/A	N/A
<b>Pencil Hardness</b>	ASTM D3363, 750 g load	N/A	N/A	N/A	N/A	PC H	PC H
						PMMA 4H	PMMA 4H
						PET, TAC 3H	PET, TAC 3H
<b>Coating Flexibility</b>	Twist each part 3 times	N/A	N/A	N/A	N/A	No cracks	No cracks
<b>Reagents</b>	Sunscreen and sebum at 60° C and 95% RH for 168 hours	N/A	N/A	N/A	N/A	No change	No change
<b>Damp Heat</b>	50° C and 93% RH for 240 hours	N/A	N/A	N/A	N/A	No change	No change
<b>Adhesion</b>	ASTM D3359	N/A	N/A	N/A	N/A	5B	5B

<sup>1</sup> 1 kg load, 1 x 1 cm head, WCA remaining ≥100°

<sup>2</sup> 1 kg load, 2 x 2 cm head, WCA remaining >90°

<sup>3</sup> 1 kg load, 1 x 1 cm head, WCA remaining >90°

<sup>4</sup> 1 kg load, 6 mm round head, WCA remaining ≥100°





## Anti-Fingerprint (AFP) Coatings for Glass

Listening to the voice of our customers in the market, our newly developed AFP coatings showcase PPG's innovation speed and ability to enable customers' success in this fast-paced electronics market. The sol-gel-based, proprietary technology can be easily applied to glass surfaces, exhibiting outstanding fingerprint hiding and excellent abrasion resistance. Fingerprints can be easily wiped with a finger, and the coated glass surface has a silky touch-feel.

### Product Features

- Excellent fingerprint hiding
- Easy fingerprint wiping
- Outstanding abrasion resistance
- Silky touch-feel

### Design/Process Benefits

- Sprayable coating

Performance Properties	Test Method	AFP508
Initial Water Contact Angle	ASTM D724	70-90°
Abrasion Resistance	<i>Minoan</i> MUNBANGSAWOO eraser, 6 mm, 1 kg load, WCA > 50°	> 3,000 cycles
Transmission	ASTM D724	92%

## Anti-Fingerprint Coatings for Metal (AFM)

The beautiful, shiny appearance of anodized aluminum has quickly become a go-to finish for consumer electronics, but fingerprint issues have limited the design choices to silver, gold or rose gold. PPG's AFM coatings solve that problem by significantly reducing visible fingerprints on metal surfaces, allowing for a wider variety of anodized aluminum colors. This nano-coating is highly transparent, providing the device surface with excellent abrasion resistance and a silky touch-feel without dulling the underlying metal effect and color.

### Product Features

- Excellent fingerprint hiding
- Easy fingerprint wiping
- Outstanding abrasion resistance
- Silky touch-feel

### Design/Process Benefits

- Sprayable coating
- Suitable for blasting and hairline metal finishes

Performance Properties	Test Method	AFM1200	AFM2100
Initial Water Contact Angle	ASTM D724	> 105°	80-100°
Coefficient of Friction	ASTM 1894	0.03	0.1-0.2
Abrasion Resistance	<i>Bonstar</i> steel wool 0000, 500 g load, 2 x 2 cm head	2,000 cycles (WCA > 85°)	500 cycles (WCA change < 10%)
	Lint-free cloth, 500 gram, 2 x 2 cm	10,000 cycles	5,000 cycles
Film Thickness (Top Layer)	N/A	~20 nm	50-100 nm



### Product Features

- Custom-designed glare reduction
- Outstanding abrasion resistance
- Good sparkling control
- High light transmittance
- Wide range of glosses

### Design/Process Benefits

- Sprayable
- Reworkable
- Low-temperature cure for energy savings and suitability to touch-panel process
- Compatible with EC coatings

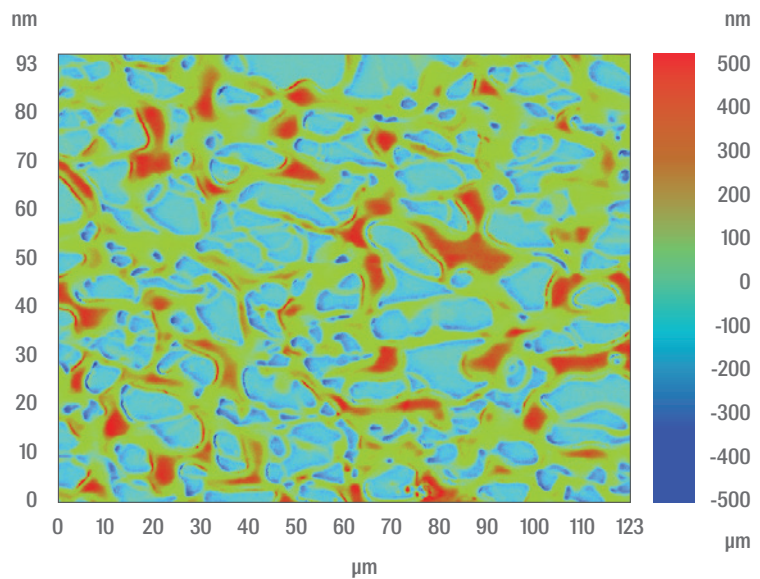
## Anti-Glare (AG) Coatings for Glass and Plastic

Designed to improve screen readability under direct indoor light or harsh sunlight, PPG AG coatings combine performance benefits – such as significant glare reduction without sparkling, wide gloss range, high light transmittance and exceptional abrasion resistance – with process advantages such as sprayability and reworkability.

PPG AG coatings can be combined with PPG EC coatings to give touchscreens a smooth, silky and slippery feel, and their low cure temperatures ( $\leq 150^{\circ}\text{C}$ ) save energy and enable compatibility with OGS (One Glass Solution) products and low-temperature inks for anti-glare applications.

### Uniform coating coverage

The optical profilometry image below illustrates the uniform nature of PPG's AG coating on a glass application.



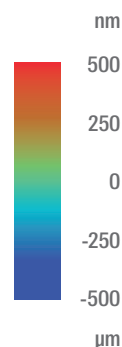
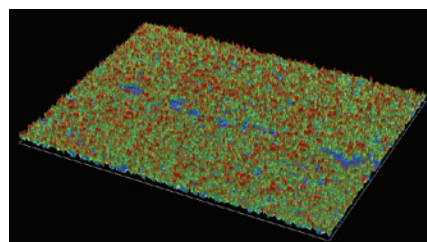
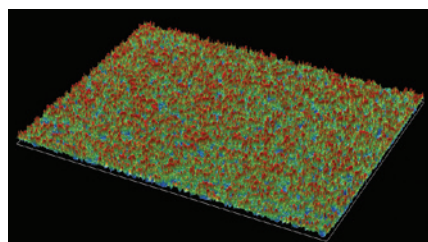
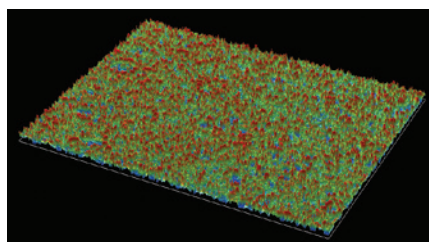
## Outstanding abrasion resistance

The optical profilometry images below show that the surface of a glass display screen finished with PPG anti-glare (AG) coating remains substantially unchanged after 100,000 abrasion cycles with a stylus pen (500-gram load) and shows only minor microscopic scratches after 150,000 cycles.

Initial Surface

After 100,000 Cycles

After 150,000 Cycles



Stylus pen test: >100,000 cycles (500 gram load)

Performance Properties	Test Method	On Glass		On Plastic
		AG201 / 203 / 306	AG + EC	AGP200
<b>Gloss @ 60°</b>	Micro-Tri-Gloss meter by BYK Gardner	40-110	40-110	40-120
<b>Haze</b>	ASTM D1003	3 – 12% or specified	3 – 12% or specified	5% - 30% (custom haze available)
<b>Transmission</b>	ASTM D1003	>89.0%	>89.0%	>89.0%
<b>Ra</b>	SURFTEST™ SJ-210 Series 178 portable surface roughness tester, or Veeco WYKO™ NT3300 optical profilometer, ≤ 2.5X magnification	0.05-0.2 μm	0.05-0.2 μm	0.1-0.3 μm
<b>Abrasion Resistance</b>	TABER™ linear abraser 5750, 1 kg load, 1 x 1 cm head, micro-fiber cloth	> 8,000 cycles	N/A	N/A
	WACOM™ stylus pen, 500 g load	30,000 cycles	> 100,000 cycles	N/A
	Taber linear abraser 5750, 1 kg load, 2 x 2 cm head, steel wool 0000	N/A	> 3,000 cycles, GU 90 >2,000 cycles, GU 60	N/A
	Bonstar steel wool 0000, 500 g load, 2 x 2 cm head, WCA remaining > 90°	N/A	N/A	1,000 cycles, haze: 5 – 10 500 cycles, haze: 15 – 20
<b>Coefficient of Friction</b>	ASTM 1894	N/A	< 0.03	N/A
<b>Film Thickness</b>	SEM cross-section	50 – 500 nm	60 – 510 nm	5 – 9 μm (high thickness for peak gloss)
<b>UV Durability</b>	QUV™ accelerated weathering	128 hours	128 hours	N/A
<b>Pencil Hardness</b>	ASTM D3363	8H, 500 g load	8H, 500 g load	PC > H, 750 g load
				PET, TAC ≥ 3H, 750 g load
				PMMA > 4H, 750 g load
<b>Pen Marking Test</b>	ZEBRA™ red marking pen, marks can be wiped off easily	N/A	N/A	Pass
<b>Adhesion</b>	ASTM D3359, crosshatch / tape adhesion	5B	5B	5B
<b>Initial DI Water Contact Angle</b>	ASTM D724	N/A	N/A	> 105°



## The best knowledge. The most resources.

Every product, application and production facility presents unique coatings challenges – and nobody knows that better than PPG. That's why we are pleased to offer our customers two unique services:

### SECURE LAUNCH EXCELLENCE™ Process

A highly regimented and proven methodology that enables OEMs to work with PPG coatings and color experts to fast-track the development and integration of new coatings into manufacturing operations.

### PPG KNOWLEDGE COLLEGE™ Training

OEM supervisory and manufacturing personnel are taught coatings basics, equipment usage and problem-solving using hands-on presentations and lab work with the goal of maximizing product performance and production efficiency.

## Global asset protection

As a global company with operations in more than 70 countries, PPG is uniquely equipped to service all of your coatings needs, including helping you meet specific, coating-related environmental mandates, troubleshooting production issues, assisting with setting up new equipment and identifying areas where your processes may be streamlined. When you partner with PPG, you gain access to world-class technical services, color expertise and a global supply chain that delivers your products reliably on time, every time, anywhere in the world.

To learn more about any of our coatings for electronic materials, please visit [ppgindustrialcoatings.com](http://ppgindustrialcoatings.com) or call one of the international sales offices listed below.



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