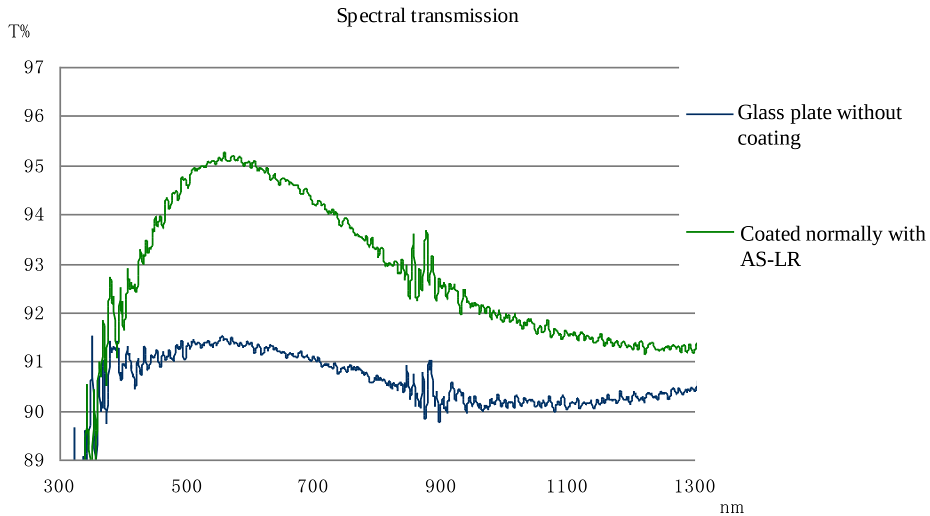
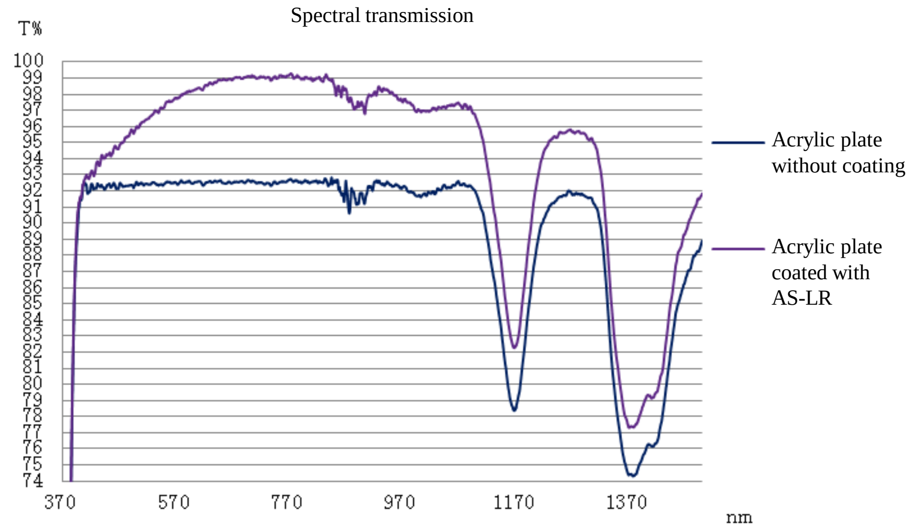
AS-LR Coat
Room-Temperature Low-Refraction Antistatic Coating Agent

JAPAN NANO COAT CO., LTD.

■ Features of AS-LR Coat

Anti-static Low Refraction (AS-LR) Coat is an antistatic, low-refraction coating agent for solar panel glass plates (patent applied for in April 2010). It not only features the advantages of our 100% inorganic silica binder, that is, high transparency, room-temperature setting and fast-drying, strong adhesion, excellent weather resistance, and super-hydrophilic property, but also good antistatic performance to prevent contamination as well as low refraction. This functional coating agent was created by using silica particles of varying diameters of less than 10 nanometer and tin oxide particles with a diameter of about 2 nanometers. The low refraction of the coating agent increases visible light transmission by more than 3% when applied to one side of a 91% glass plate, and by more than 7% when applied to both sides. An acrylic plate coated on both sides has light transmission of 99%. The agent increases the light transmission of a PET film from 85% to 89% (+4%) and that a polycarbonate film from 90% to 94% (+4%).

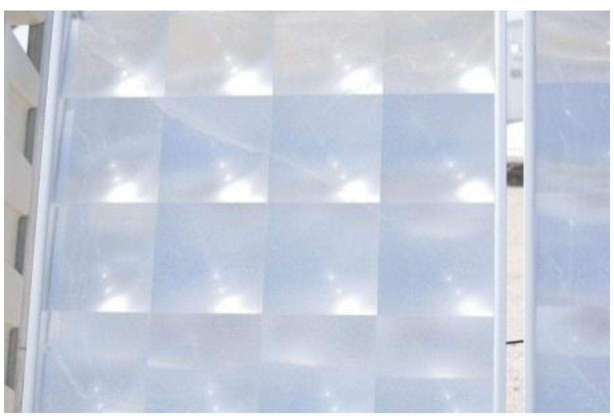




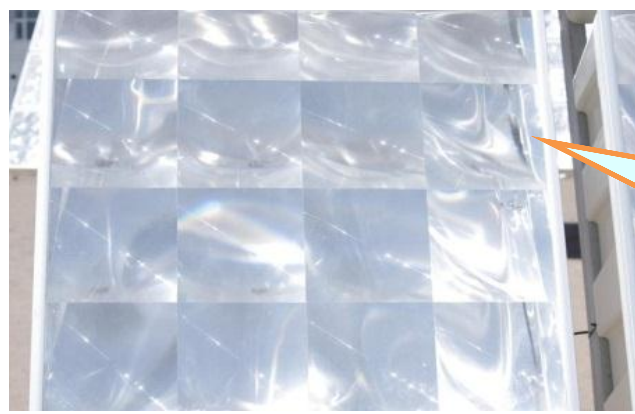
■ Necessity of AS-LR Coat

The solar panel market is rapidly expanding in Japan and worldwide. In particular, solar power plants are being constructed in the Middle East, which have more than 12 hours of sunshine on average (5.5 hours in Japan). However, since these plants are constructed in rainless desert, longer sunshine hours lead to reduced power generating capacity due to the adhesion of sand and dirt. Thus, to maintain power generation efficiency, the solar panels must be cleaned daily, as the efficiency falls by up to 20% if not cleaned (a decrease of 16% was measured in California, U.S.A.).
In rainless desert, the air is dry and therefore sand is electrically charged and easily sticks to solar panels. Thus, the solar panel surfaces need to be treated with an antistatic to stop the sand from sticking. The following pictures show how an antistatic agent effectively prevents sand from sticking to a solar panel installed in a desert outside of Xian in China, for three months after the coating agent was applied. As the pictures show, sand has accumulated on the panel without an antistatic coating, causing a 10% decrease in power generation capacity.

Panel without coating



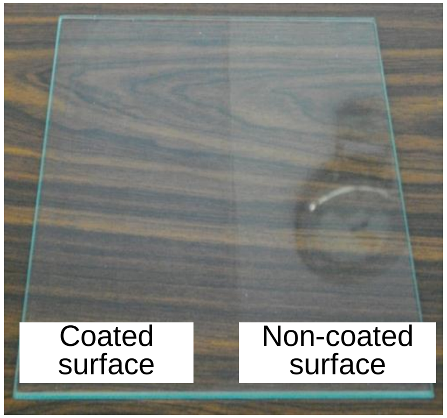
Panel with coating



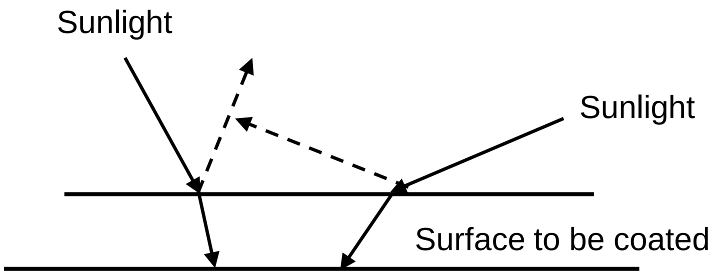
The antistatic coated sections effectively prevent sand and dirt.

■ Low refraction effect of AS-LR Coat

Solar panels need a higher power generation capacity. Lighting equipment such as LED devices need to be brighter. Transparent glass and transparent resin plates such as acrylic, polycarbonate, and PET plates for computers and smartphones need to transmit light efficiently by controlling the refraction of light to minimize the energy loss caused by reflection from these transparent plates. Light transmits through a low refraction film as shown in the diagram on the right: light is normally reflected along the dashed lines from the surface. The low refraction film reduces the reflection, facilitating efficient transmission of light. Thus, applying a coating agent to a transparent base plate made of glass, acrylic resin, polycarbonate, or PET improves the light transmission.

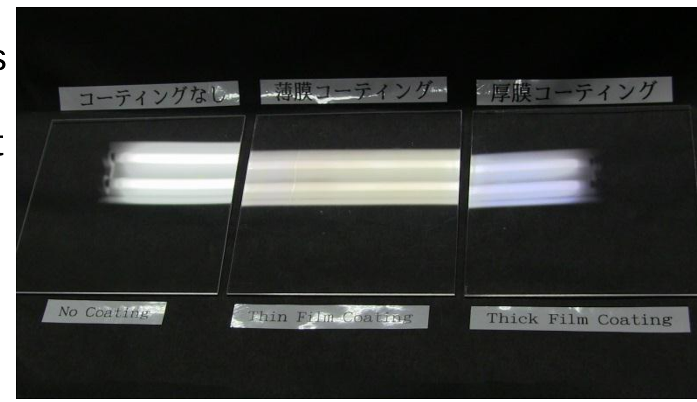


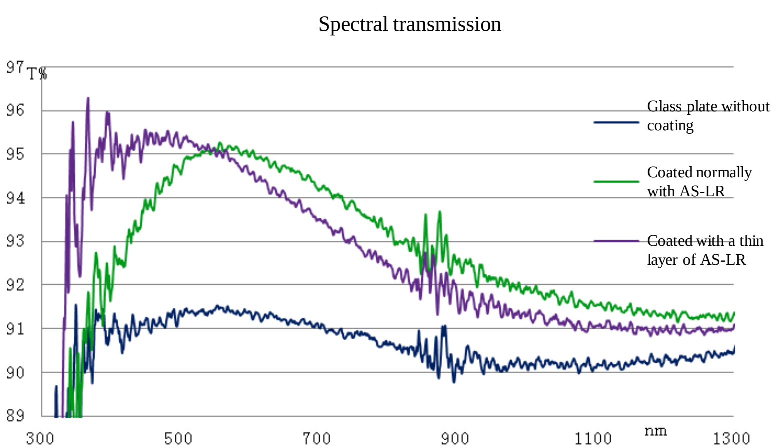
The left-hand surface looks darker because of lowered reflection of sunlight, indicating an increase in light transmission.

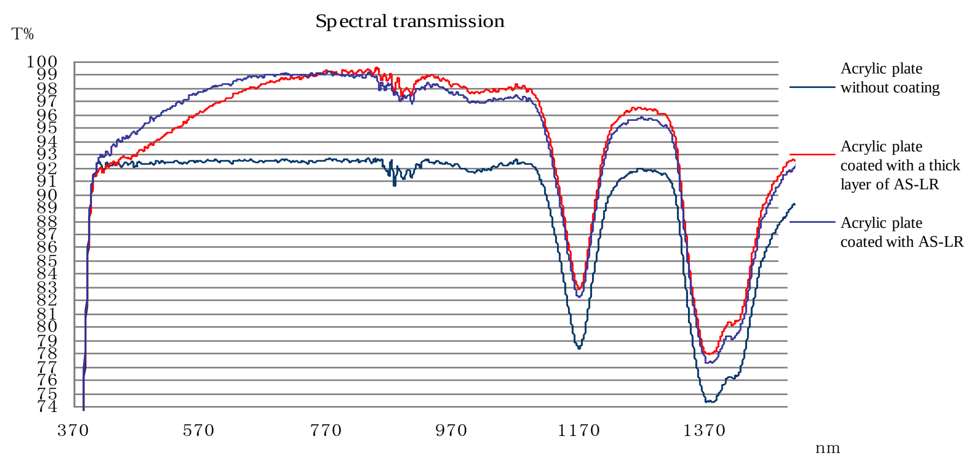


■ Change in efficiency with the thickness of AS-LR Coat

Solar panels made by different manufacturers have different wavelength regions for power generation.
In general, the highest efficiency of thin film solar panels is at 550 nm in the visible light region, whereas that of polycrystalline solar panels is in the region from 800 to 900 nm. Thus, the amount of coating agent should be controlled so that each solar panel module has the best efficiency in the most suitable wavelength region.
The following graphs show how light transmission changes with the thickness of coated agent. These graphs suggest that as the amount of coating agent increases, the highest positions of the spectral transmission curves tend to shift from the ultraviolet range, to the visible light region, and to the infrared region. Therefore, it is important to control the thickness of AS-LR Coat uniformly at the nanometer level.



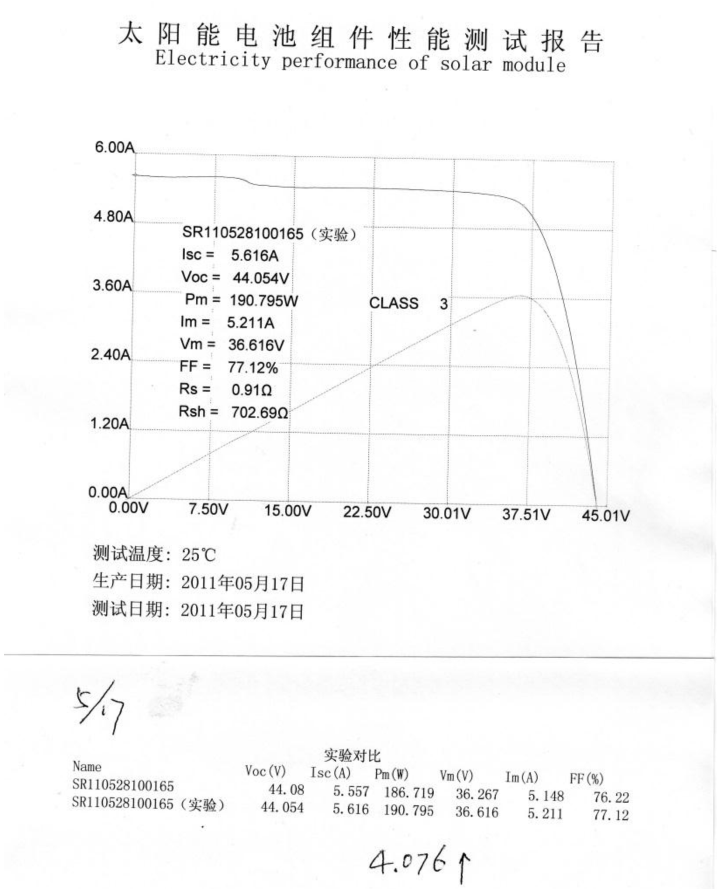




■ Physical properties of AS-LR Coat

Physical properties of AS-LR Coat	
Test specimen	Glass base material
Optical properties	
Visible light transmission (one side)	94% or higher
Visible light transmission (both sides)	97% or higher
Visible light reflectance	2% or less
Haze factor	0.5% or less
Refractive index	1.33-1.36
Physical properties	
Surface resistivity	10^8 Ω/□
Contact angle (water)	5ºC or less
Cross-cut adhesion test (tape peeling)	100/100
Pencil hardness	4H or higher
Adhesion (boiling water test: 1 hour)	No observable abnormality
Adhesion and moisture resistance (steam test: 1 hour)	No observable abnormality
Environment resistance	
Weather resistance (Q-UV: 875 hours)	No observable abnormality
Weather resistance (super UV: 500 hours)	No observable abnormality
Heat resistance: 200˚C, 2 hours; or 300˚C, 1 hour	No observable abnormality
Cold weather resistance: -20˚C for 1 month	No observable abnormality
Cold weather resistance: -18˚C / 20˚C at 30-minute intervals (5 times)	No observable abnormality
Chemical resistance	
Etching test: 30%-hydrochloric acid for 5 minutes and 30%-sodium hydroxide for 5 minutes	No observable abnormality

■Actual performance of AS-LR Coat—Part 1


太 阳 能 电 池 组 件 性 能 测 试 报 告
Electricity performance of solar module

测试温度：25℃
生产日期：2011年05月17日
测试日期：2011年05月17日

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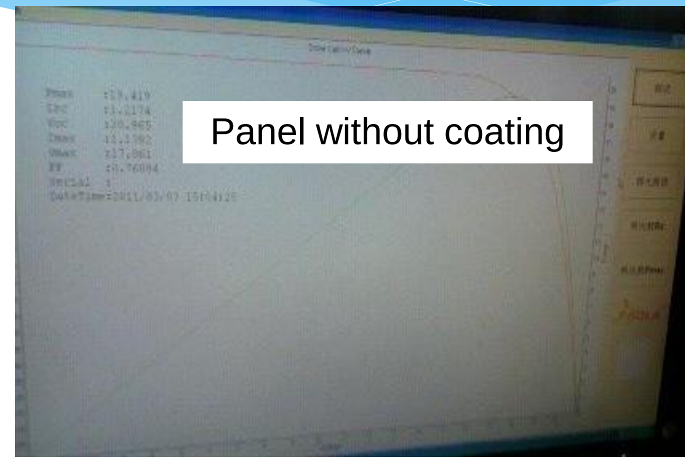
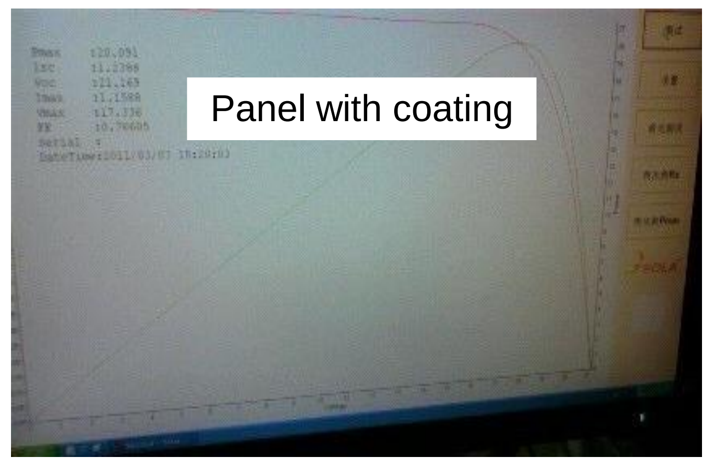
实验对比

Name	Voc (V)	Isc (A)	Pm (W)	Vm (V)	Im (A)	FF (%)
SR110528100165	44.08	5.557	186.719	36.267	5.148	76.22
SR110528100165（实验）	44.054	5.616	190.795	36.616	5.211	77.12

4.076 ↑





A Chinese solar panel manufacturer confirmed an efficiency increase of approximately 2.2% (power generation capacities before and after coating: 186.719 W and 190.796 W, respectively). A solar panel manufacturer in northeastern China confirmed an efficiency increase of approximately 3.4% (power generation capacities before and after coating: 19.419 W and 20.091 W, respectively). In addition, a Southeast Asian solar panel manufacturer confirmed an efficiency increase of 2% (manual application) and 4% (mechanical application).

■ Actual performance of AS-LR Coat — Part 2

Panel without coating

Panel with coating

These two pictures show solar panels placed in a mountainous area in northeastern China for 6 months. The solar panel coated with AS-LR Coat clearly prevented sand and dirt, whereas the panel without coating was covered with sand and its efficiency was reduced by more than 10%.

			Voc(V)	Isc(A)	Pmax(W)	Vpm(V)	
SCE011029-1345	2012/1/31	10:36:08	44.78484	5.63483	191.4011	36.62565	塗り前
SCE011029-1345	2012/3/22	12:32:53	44.5863	5.636312	189.9544	36.19965	塗り後
					-0.76%		
SCE011029-1347	2012/1/31	10:37:15	45.01142	5.621938	192.539	36.98962	手塗り前
SCE011029-1347	2012/3/22	12:33:26	44.52917	5.693213	191.6658	36.16331	手塗り後
					-0.45%		

结果显示，使用同一批次同一档位生产的手工涂防尘膜组件与普通组件，经过大约2个月室外暴晒，手工涂膜组件功率衰减情况优于普通组件。但手工涂膜工序较复杂，需要专业人员进行涂膜。

The above table shows the results of an outdoor-exposure test. It compares a hand-painted panel and an ordinary panel produced at the same time under the same conditions. The table proves that the hand-painted panel is superior in efficiency reduction. However, the hand-painting process is more complex and requires expert workers.

The table shows the results of an outdoor-exposure test performed in the suburbs of Shanghai. The results proved that the two solar panels coated with AS-LR Coat maintained almost the same power generation capacity for two months after the coating, with an efficiency reduction of -0.76% and -0.45%, respectively. The solar panel without coating lost 6% efficiency from the initial value.

The animation of an AS-LR coat is here. http://www.youtube.com/user/MiyakoRoller

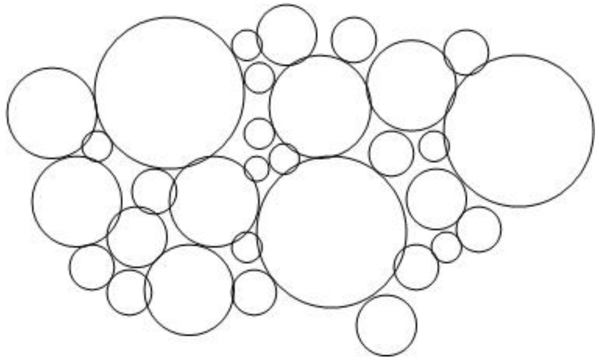
JAPAN NANO COAT's Inorganic Binder Technology and Primer Technology

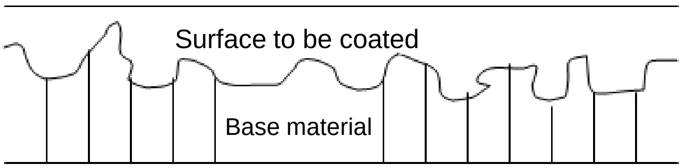
■ Key technologies for developing nano-tech coating agents

There are three key technologies for developing nano-tech coating agents: (1) pulverization and elution technology by which the raw material is pulverized, melted, and eluted into primary particles of 1 nm in size, (2) dispersion technology by which nano-sized raw material is uniformly dispersed into a solvent (water, alcohol, and solvent), and (3) binder (adhesion) technology for allowing functional materials to securely adhere to base materials. These three technologies are essential for practical use. Technologies related to items (1) and (2) have been actively developed by research institutes such as major chemical manufacturers and universities. However, there have been few studies on item (3): practical approaches are to use organic resins or organic-inorganic hybrid materials or to apply heat for adhesion. Thus, to take advantage of functional materials at room temperature, we are conducting research on transparent inorganic 100% pure binders that show little deterioration.

■ Binder technology

All base materials including glass, polycarbonate, stainless steel, and resin have invisible minute asperities on their surfaces although they appear to be flat. The binder technology ensures adhesion to all raw materials by controlling various inorganic silica-based particles of less than 10 nm in size. In addition, the use of minute binder particles causes functional materials such as titanium oxide (photocatalyst) and tin oxide (antistatic material) to move to the surface of the coating agent, thus enabling the functions to be added very efficiently. Coating sometimes requires the use of a primer because every base material has a different surface. In general, inorganic binder is heated to a high temperature to cause the organic components in the binder to volatilize and to change the binder into 100% pure inorganic binder. However, our binder uses the coagulation strength (intermolecular force) of silica-based inorganic oxides. It becomes a transparent, strong-adhesion thin film at room temperature when its coagulation strength, which changes simultaneously with volatilizing solvent, is properly controlled.





Base material: Glass, PC, stainless steel, tile

JAPAN NANO COAT's Inorganic Binder Technology and Primer Technology

■ Features of our binder technology

Single-nano-sized silica-based binder formed at room temperature enables strong adhesion, high transparency, and good weather resistance.
The binder has the following features:
Stable antifouling in the absence of light because of its hydrophilic property
Inorganic, safe, and semi-permanent
Applicable to any material, whether organic or inorganic, because of its strong adhesion
Applicable to water-based, alcohol-based, and solvent-based materials (versatile)

What is the binder technology?

The binder technology (adhesion technology) requires the following:

(1) Strong adhesion to base materials
(2) Strong adhesion to functional materials
(3) Minimum interference with the property of functional materials
(4) Long-lasting effect

Items (3) and (4) depend on binder properties. Our binder can be used with various functional coating agents when mixed with functional materials with the required functions.

Examples: Inorganic binder + titanium oxide = Photocatalytic coating agent
Inorganic binder + tin oxide = Electrically conductive coating agent
Inorganic binder + iron oxide, cerium oxide, and zinc oxide = UV-cutting coating agent
Inorganic binder + ATO and ITO = Infrared-cutting coating agent

JAPAN NANO COAT's Inorganic Binder Technology and Primer Technology

■ Application of JAPAN NANO COAT's binder technology

- Antistatic and antifouling coating agent for outer walls
- Super-hydrophilic antifouling coated curved mirrors
- Primer for hydrophilic resins
- Infrared and ultraviolet-cutting transparent coating agent for window glass
- Anti-reflection coating agent
- Low-refraction, antistatic, and antifouling coating
- High-refraction, antistatic, and antifouling coating
- High-refraction coating agent
- Transparent, conductive coating agent
- Photocatalytic coating agent
- Antibacterial, anti-fungal coating agent
- AR coating agent for solar panels
- AR coating agent for smartphones and liquid crystal panels
- Coating agent for polycarbonate, acrylic, and PET materials
- Coating agent for automobiles
- Coating agent for building materials such as sound insulation walls

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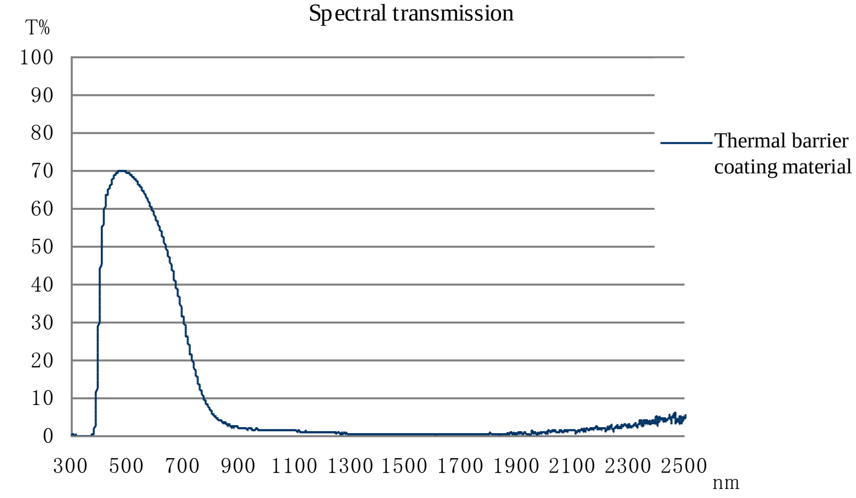
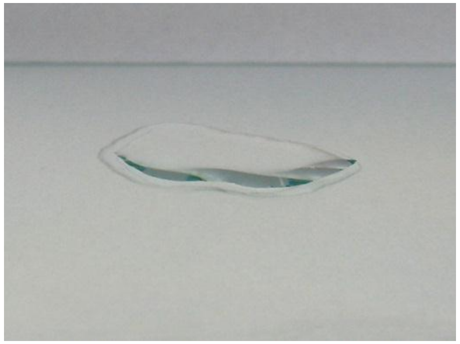
Graph of infrared and ultraviolet-cutting coating



AS-LR coating
Hydrophilic and low-refraction



High-refraction and water-shedding coating
Fingerprint prevention