

Additives for plastic coatings

“Surface Control Agents Leveling, Slip, Anti-Scratch and Anti-Stain”

1. Introduction

Plastics are flexible and light materials and they are widely used for various products such as cellular phones and laptops. However, some plastic properties like hardness, color and gloss are often insufficient to meet the market's demands. That's the reason why plastic coatings are needed.

In general, isocyanate cure coatings and UV cure coatings are used for plastics. Coating films are classified to three types, primers, base coats and top coats. For plastics, top coats are especially important. For example, we carry around cellular phones and use them for a long time. Of course we care about appearance and colors of cellular phones. Therefore top coats need to have durable and beautiful surfaces, and then leveling, slip, anti-scratch and anti-stain properties are generally requested for top coats of plastic coatings.



In this document, we would like to introduce our additives which provide these various required properties.

2. Leveling, slip, anti-scratch and anti-stain properties for clear top coats

1) Additives for plastic coatings

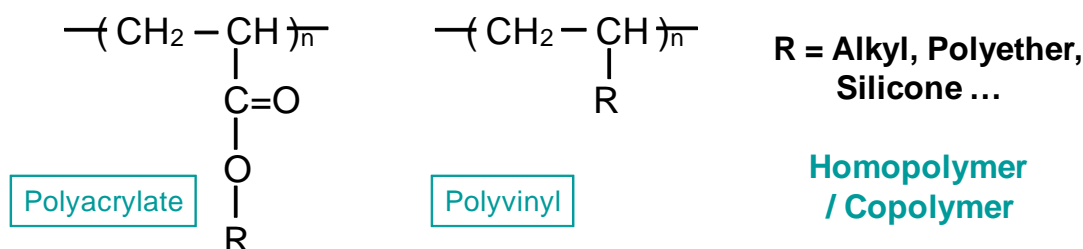
Isocyanate cure coatings and UV cure coatings are often used for plastics as clear top coats. There is wide variety of resins, and various needs such as improvement of leveling, anti-scratch and anti-stain properties. Therefore, we have to select the appropriate additives to fulfill the requirements for each type of resin.

First, we would like to introduce our surface control agents as follows:

Acrylic /Vinyl Polymer Type

Features: Slightly reducing the surface tension of coatings
 Improving the leveling
 Less trouble with poor adhesion, cratering, cissing, and foaming etc
 Excellent recoatability (excellent printing properties)

Fig1



Silicone Type (Polysiloxane / Modified Polysiloxane)

- Features: Significantly reducing surface tension of coatings
- Improving the leveling
- Providing slip, anti-scratch and anti-cratering properties
- Small dosage

Polyether-modified polysiloxane

Pendant structure

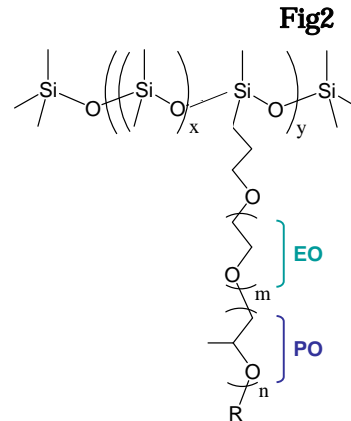


Table2. Type of additive

Product	Chemical type	Advantage
SPL-70, SPL-71	Acrylic / Vinyl Polymer with Silicone	Good Balance of Leveling and Slip
SPL-80	Acrylic-Silicone Copolymer	Recoatibility (Printing property)
SPL-90, SPL-91 SPL-92, SPL-93, SPL-94	Silicone	Slip / Anti-Scratch

Surface tension order

Silicone Acrylic / Vinyl polymer with Silicone < Acrylic-Silicone copolymer
 SPL-93 SPL-92 < SPL-91 < SPL-94 < SPL-90 < SPL-70 < SPL-71 < SPL-80



Generally, additives which reduce surface tension significantly (like silicone type) need only small amounts of dosage and can impart slip, anti-scratch and anti-cratering properties very well. However this kind of additives may inhibit the inter coat adhesion.

On contrary, additives which reduce surface tension slightly (like acrylic/vinyl polymer type) have mild effects and tend not to cause problems such as inter coat adhesion, cratering and foaming.

We offer a wide range of additives to meet the various needs in various resin systems.

1) Improvement of leveling

Isocyanate cure coatings are also called 2KPU coatings. "2K" means two-component (2 Komponent in German) and "PU" stands for polyurethane. In this coating system, films are formed by the reaction of a polyisocyanate with a polyol. Since isocyanate cure coatings are tough and look thick, the coatings are used for base coats and top coats of plastics.

Below you can find the leveling test result of our additives in a 2KPU coating.

We adjusted the solid content of different kinds of leveling additives to 0.05% and applied the paint by air spray. Then we evaluated leveling improvement by checking the coating film reflected images of fluorescent light tubes. A flat and smooth surface gives sharp images.

The results are as follows:

Table3. Effect of leveling additives

Additive	Leveling	Anti-cratering	Slip
Blank	1	1	1
SPL-80	5	5	1
SPL-93	5	5	5

Excellent : 5 Poor :1

In the 2KPU coating, SPL-80 and SPL-93 showed excellent leveling and anti-cratering effects. (Table2 & Photo 1)

SPL-80, an acrylic-silicone copolymer, doesn't contain free-silicone. So SPL-80 could achieve excellent leveling and anti-cratering effect without a recoatability problem. On the other hand, the silicone based product SPL-93 imparted excellent slip properties to the coating. (Table 2)

Photo1. Leveling improvement



BLANK

SPL-80

SPL-93

3) Slip and anti-scratch properties

Plastics have excellent formability, but the surfaces are soft and get scratched easily. So UV hard coatings such as urethane acrylate are often applied to plastics for surface protection. UV hard coatings have a good scratch resistance, but the anti-scratch properties can be improved with additives. An additive which provides excellent slip property can reduce the friction resistance of a coating film and prevent the film surface from getting scratched. You can feel the slip effect by rubbing a film with a cloth.

UV coatings composed of urethane acrylate resins are quite hard. The hardness of the film is usually over 5H in pencil hardness test. Thus we used a rubbing meter with steel wool to evaluate the scratch resistance. (Photo 2)

Generally, we can find scratches on films which are rubbed about 50 times by a rubbing meter, with some silicone based additives, scratches will not be observed even after 150 times rubbing.

Photo2



Steel wool #0000

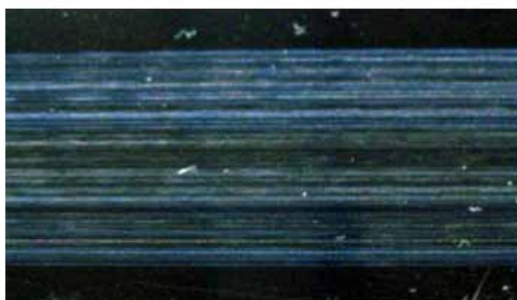
Rubbing meter (Suga test instruments Co., Ltd.)

The pictures (Photo 3) show how the scratch resistance can be improved by an additive.

We prepared two films of a 2KPU coating, one didn't contain any additive and the other contained 0.5% SPL-92 which is a silicone based surface control agent. Those films were rubbed 1000 times by a rubbing meter with gauze.

2KPU films are softer than UV coatings. As shown in the picture, there were a lot of scratches observed on the Blank film. The film with SPL-92 didn't get scratched much. Moreover, the value of 20° gloss of the SPL-92 film was higher than the Blank.

Photo3. Anti-scratch



Blank
20° Gloss 82.2

SPL-92
90.8

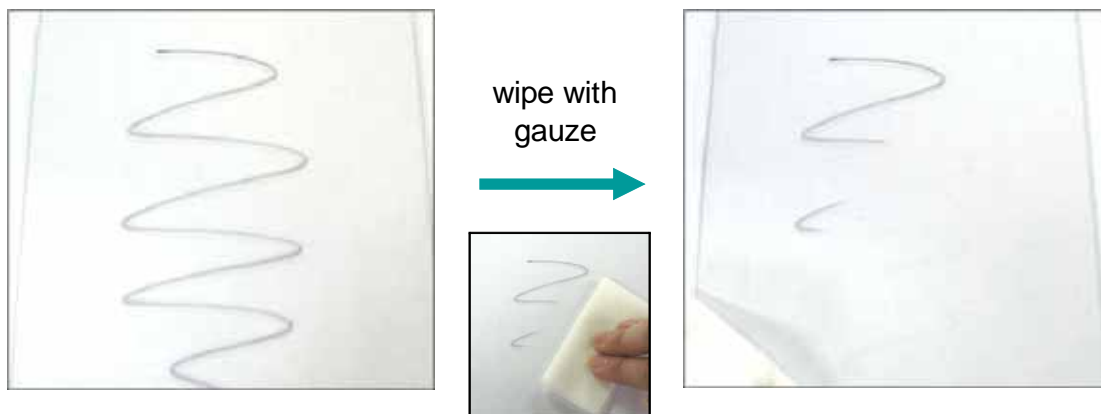
4) Anti-stain and easy-cleaning properties

Recently, touch panels are widely used for smart phones, computers and vending machines etc. Like touch panels, there are a lot of products which are required to have anti-stick (anti-stain / anti-fingerprint) properties and easy-cleaning properties. A smooth and slippery surface is also important.

To meet these requirements, some additives which have a low surface tension are used. There are two types of this kind of product, the silicone-based type and fluorine-based type. We would like to introduce a silicone-based product here.

As shown in the pictures (Photo 4), a line drawn by a marker pen on the film which contains a silicone-based product is easily wiped off with a dry gauze.

Photo4 Easy-cleaning

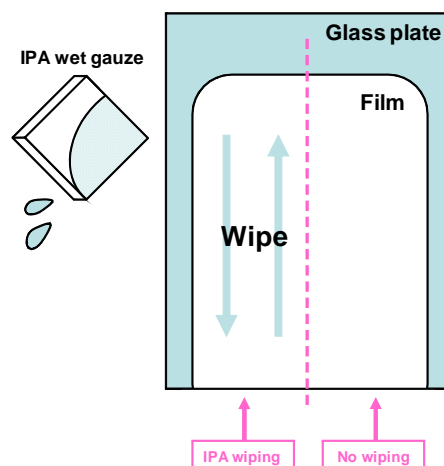


Keeping this kind of effects is also important. There are some common silicone products which have excellent slip, anti-stain and easy-cleaning properties at first. However, repeated wiping, touching and cleaning removes the silicones from the film surfaces and the effect will not last. A product which can react with the resin keeps the effect for a long time since it is fixed on the film surface.

This is an evaluating method of an easy-cleaning effect and durability. (Fig 3)

First, wipe half of the film 50 times with an IPA wetted gauze. Then draw a line on the film with a marker pen. Finally, wipe the line on the film with dry gauze and compare the IPA Wiping Part to the No Wiping Part.

Fig3.
Evaluation method
of easy-cleaning
and durability



LS-280 is a hydroxy-functional silicone leveling and slip agent. The features are excellent slip, anti-stain, anti-slip and easy-cleaning properties. We evaluated LS-280 in a 2KPU coating and compared it with the Blank and the non-reactive silicone product (Conventional product). Additive dosages are 0.03% solid.

The marker line on the Blank film was never erased. The non-reactive conventional product lost the easy-cleaning effect after IPA wiping. LS-280 showed an excellent easy-cleaning effect whether wiped or not. (Photo 5)

Photo5. Easy-cleaning properties and durability



As mentioned in the document, many properties such as leveling, slip, anti-scratch and anti-stain are required for plastic coatings. And we offer a wide range of additives to meet your various needs in various resin systems.