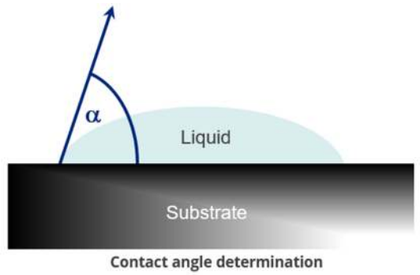
Superior surface properties can not be achieved without the addition of surface control additives that alter the surface properties of the coating, ink and plastic films. Depending on the kind of additive used, the following properties can be improved:

- **Slip** (commonly named lubricity) represents the ability of two surfaces to glide over each other without causing any mechanical damage. Good slip properties require that the slip additive concentrate to the surface during and immediately after application and curing.
- **Abrasion** is a phenomenon caused by the mechanical action of rubbing, scraping or erosion. Since it is intimately related to scratch and slip, it is not surprising that many slip additives also function as mar and abrasion resistance additives.
- **Mar**, **scratch** and **metal marking** are the damages on the surface of a coating from surface abrasion, typically sliding objects, fingernails, etc.
- **Anti-blocking** defines a non-stick condition between two surfaces or the resistance to adhesion between two surfaces under the influence of temperature, relative humidity or even pressure.
- **Levelling** is the ability of a liquid to go from irregular liquid film to a level film (during curing/drying).

Wetting, by itself, generally means the spreading of one substance, usually a liquid, over a substrate, such as a solid. Wetting is normally a surface tension-driven spreading that happens when a liquid or gas of lower surface tension is in contact with a surface, such as a liquid or solid, of higher surface tension.

When spreading occurs, the angle between spreading layer and the non-wetted substrate is zero. This is called contact angle (α).



Contact angle determination

Surface control additives are silicones, polyacrylates or perfluoro surfactants.

Polysiloxanes (Siloxanes) have a very high surface activity and therefore are often used as surface control additives. They are generally modified by polyethers, polyesters or alkyl side groups to improve recoatability and inter-coat adhesion. Modification parameters are silicone content, molecular weight, and modification degree.

Polyacrylates (Homo- and copolymers) based on (meth)acrylic monomers are well known polyacrylate surface control additives. In some cases, they are incompatible in the paint system, which leads to the development of haze in clear-coats. In addition to their positive impact on flow and leveling, polyacrylates are effective as air-release agents.

Perfluoro surfactants (Perfluoroalkyls) are the most effective compounds to decrease surface tension. However, recoatability and foam stabilization and cratering may occur. These undesired side-effects depend very much on the system parameters that have to be optimized to gain optimum

Surface Control Additives KAM-SCA®

results. Controlling the parameters of molecular weight, polarity, degree of fluorine modification, and additive concentration in the formulation must be evaluated carefully.

Surface defects that can be overcome by using surface control additives:

Crawling and De-wetting
Tendency of a wet paint film to recede from certain areas of a painted surface leaving them apparently uncoated. It is caused by an incompatible film on the surface or a substrate with too low surface tension (e.g. plastic).

Cratering
Formation of small bowl-shaped depressions in a coating film.

Fish Eyes
Crater-like holes.

Orange Peel
A surface bumpiness or waviness that resembles the skin of an orange.

Edge crawling
De-wetting of the applied coating and the appearance of fat edges or picture framing around the edges of a panel or metal part.

Pinholes
Channels resulting from slow rising air bubbles that cannot flow together and form pinholes.

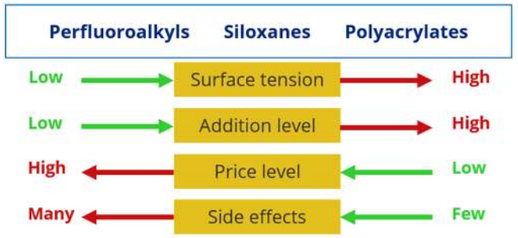
Bénard cells and Silking
Polygonal (hexagonal) cell patterns, micro-separation of pigments in the film due to surface tension gradients.

Air draft sensitivity
Loss of wetting in local regions of higher surface tension caused by irregular evaporation of solvent due to air flow (ventilation or forced drying).

Roller and Brush marks
Strikes left after application of the paint by a brush or roller.

Blistering
Bubbles resulting from localized loss of adhesion, and lifting of the paint film from the underlying surface.

Respective properties and characteristics of surface control additives are described in detail in below tables:



Chemistry	Type of Modification	Surface tension (0=No reduction-5=Strong reduction)	Foaming/defoaming (F=Foaming/D=Defoaming)	Levelling (0=No levelling-5=Strong levelling)	Substrate wetting (0=No sub. wetting-5=Strong sub. wetting)	Inter-coat adhesion (0=No affected-5=Strongly affected)	Anti-cratering (0=No anti-cratering-5=Strong anti-cratering)	Slip (0=No slip-5=Strong slip)
Polysiloxanes	Pure polydimethylsiloxane	4	D	4	2	5	5	5
	Polyether-modified	4	F	4	4	2	5	3
	Aralkyl-modified	3	D	4	4	5	4	4
Polyacrylates	Unmodified	2	D	4	1	0	1	0
	Perfluoro-modified	4	D	4	4	0	3	0
Perfluoro surfactants		5	F	0	4	0	5	0

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Trade name	Description/Composition	Dosage %	Solids %	Features & benefits	Acid curable	Acrylic OH-functional	Acrylic self-crosslinking	Acrylic thermoplastic	Long-oil alkyd	Medium-oil alkyd	Short-oil alkyd	Alkyd & PE OH-functional	Alkyd & PE melamine	Chlorinated rubber	Solvent-based epoxy	Solvent-free epoxy	Nitrocellulose	Unsaturated polyester	Silicon resin	Vinyl copolymer	Acrylic emulsion	Acrylic water-reducible	Alkyd emulsion	Alkyd melamine	Alkyd water-reducible	Epoxy	Polyester melamine	Polyurethane emulsion	2K polyurethane	UV Curable	Packaging inks (Gravure/Flexo/Screen)	Water-based inks	Ambient Curing Systems	SMC/BMC	PVC (Plastisols/Compounds)	Thermoplastics	PUR Foams	Water-based	Solvent-based	Solvent-free & Reactive
					Solvent-based Coating																Water-based Coating									Ink			Composite						A & S*		
KAM-SCA 30	Solution of a polyether-modified polydimethylsiloxane	0.1-1.0 upon total formulation	52	Medium reduction of surface tension/Medium increase of surface slip. Cost-effective	●	●	●	●		●	●	●	●	●	●		●		●	●	●	●	●	●	●	●	●	●			●	●								
KAM-SCA 31	Solution of a polyester-modified polydimethylsiloxane	0.1-0.3 upon total formulation	52	Strong reduction of surface tension/Strong increase of surface slip. Heat-resistant	●	●	●	●		●	●	●	●	●	●		●													●	●								●		
KAM-SCA 32	Solution of modified polysiloxane	0.05-0.6 upon total formulation	51.5	Non- to medium-polar systems. Unsaturated polyester and epoxy resins. Very good leveling	●		●		●	●			●		●	●		●															●	●	●	●					
KAM-SCA 33	Solution of a polyether-modified siloxane	0.1-1.0 upon total formulation	15	Improved surface flow/Excellent compatibility in clear coats	●	●	●		●	●	●	●	●	●	●	●	●														●		●							
KAM-SCA 34	Fluorocarbon-containing organically modified siloxane	0.05-0.5 upon total formulation	52.5	Designed for substrate wetting, anti-cratering and levelling of the solvent- and water-based coatings		●	●	●	●			●	●	●	●	●			●	●		●	●	●	●	●	●	●	●			●								
KAM-SCA 36	Solvent-free modified polysiloxane	0.05-0.5 upon total formulation	>98	Pigmented solvent-based wood finishes and Industrial coatings. Solvent-free floor coatings	●		●		●	●			●		●	●		●															●	●	●	●					
KAM-SCA 39	Solvent-free modified polysiloxane	0.05-0.5 upon total formulation	>98	Similar to KAM-SCA 36 but stronger defoaming properties	●		●		●	●			●		●	●		●															●	●	●	●					
KAM-SCA 580	Solvent-free modified polysiloxane	0.1-1.0 upon total formulation	>98	Strong reduction in surface tension. Good substrate wetting, levelling and anti-cratering																	●	●	●	●	●	●	●	●	●			●						●		
KAM-SCA 772	Solution of a fluorinated polyacrylate	0.4-2.0 upon total formulation	60	Wide compatibility. Ideal for use in clear coatings. Good leveling and anti-cratering	●	●	●	●	●	●	●	●	●								●	●	●	●	●	●	●	●	●			●						●	●	●
KAM-SCA 777	Solution of a fluorinated polyacrylate	0.4-2.0 upon total formulation	70	Excellent combination of low foam, substrate wetting and leveling properties	●	●	●	●	●	●	●	●	●		●	●		●	●											●									
KAM-SCA 90	Solvent-free modified polysiloxane	0.05-0.50 upon total formulation	>98	Excellent slip, surface smoothness and 'soft-touch' effect. Ideal for high gloss systems	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●					●	●	●
KAM-SCA 360	Polymeric fluorocarbon compound	0.1-1.0 upon total formulation	>98	Very effective anti-cratering and flow control agent. Reduces surface tension drastically	●	●	●					●	●		●	●														●									

* Adhesives and Sealants

● Suitable/Recommended

● Potentially suitable