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How to Formulate UV Flexo

Flexography is the major process to print packages. There are many different applications where UV Flexo has been developed in the past few years because the versatility of the UV/EB technology makes it suitable for a wide variety of substrates used in the packaging industry such as cartons and plastics. The success of UV inks and over print varnishes also lies in the fact that it improves a lot the image quality and the film resistance.

Following the evolution of UV flexo and the demand for high performance materials, Sartomer has continuously developed monomers and oligomers optimized for this printing technology.

Flexo Ink – Requirements and Challenges

What people are willing to achieve with an ink is most of the time :

- Fast cure
- Film resistance
  - Scratch
  - Solvent
- Adhesion to various plastics/paper
- Gloss

But there are also some requirements which directly result from the printing process. This is particularly true for flexographic formulations which have to fulfill the following needs :

- Low viscosity
- Excellent flow
- Minimum plate swell

Typical UV-Flexo Ink Composition

Component	% range
Pigment	15-20
Monomer	40-60
Oligomer	15-25
Additives	1-2
Photoinitiators	10-12

UV flexographic inks usually have a viscosity of 300 to 1200 mPa.s at 25℃. This is mainly linked to the anilox roll where the ink has to fill the cells correctly.
For this reason, UV-Flexo inks usually contains in majority monomers to achieve this low viscosity criteria.

Selection of UV Curable Monomers for flexo

Sartomer has developed a wide range of monomers, most of them being suitable for flexo. However it is crucial to carefully design the monomer part of the formulation to avoid the plate swell.

How to Reduce Viscosity ?

A very simple way to cut the viscosity of the pigment concentrate is to use monomers with a high solvency and low viscosity. The following monomer are typically used to that purpose :

Monomer		Viscosity (mPa.S@25℃)
SR341	MPDA	4 - 8
SR508	DPGDA	8 - 14
SR306	TPGDA	10 - 20
SR9003	PONPGDA	13 - 20

How to Achieve Adhesion to Plastics ?

There are several way to achieve adhesion :

- Use an adhesion promoting oligomer
- Target low surface tension material to improve the wetting. The ink will wet correctly the substrate if its surface tension is lower than the substrate's surface tension.
- Use low molecular weight monomers to swell the substrate. If adhesion is difficult to achieve and require the use of such products, the amount should not exceed 5-10% of the formulation to avoid the plate swell.

The table below tells which monomer tend to swell or wet several plastics.

Monomer		γ mN/m-20℃	Mw g/mol	Adhesion				
				PVC	PS	PC	PET	ABS
SR420	Isophoryl Acrylate	27	195		↗			
CD536	DOGDA	28,4	256	↗	↗	↗		↗
SR395	IDA	28,6	212		↗			
SR489	Tridecyl Acrylate	28,9	255		↗			
SR341	MPDA	32	226	↗	↗	↗		↗
SR531	CTFA	35,3	200	↗	↗	↗		↗
SR285	THFA	36,1	156	↗	↗	↗	↗	↗
SR339	PEA	37,8	192		↗	↗	↗	↗

Adjusting film properties with monomers

With the wide range of monomers Sartomer can offer to the formulator, a judicious choice of materials will help reaching the desired properties. The list of monomers below will lead you in the development of your formulation :

SR339C (2-PEA)
- Low viscosity
- Adhesion
- Xi free

SR531 (CTFA)
- Flexibility
- Excellent diluant when mechanical properties are required
- adhesion

SR341 (MPDA), **SR508** (DPGDA),
- Low viscosity
- Excellent cutting power

SR9003 (PO NPGDA)
- Low viscosity
- Good pigment wetting
- Xi Free

SR355* (DiTMPTA), **SR399LV*** (DiPEPA), **SR454** (3EO TMPTA), **SR494** (PPTTA)
- Surface cure
- Chemical resistance
- Hardness
- * Xi Free

CD536 (DOGDA)
- Low surface tension
- Chemical resistance
- Excellent thermal stability

SR601E (4EO-BisA-DA), **SR349** (3EO-BisA-DA)
- Fast curing
- Scratch resistance
- Xi free

SR492
- Excellent Pigment Wetting
- Grinding capabilities

Selection of UV Curable Oligomers for Flexo

Although the oligomer part usually not exceed a third of the formulation, it is crucial to select them carefully. The oligomer chosen to prepare the pigment concentrate will affect the properties of the final ink system. It will especially affect the following parameters :

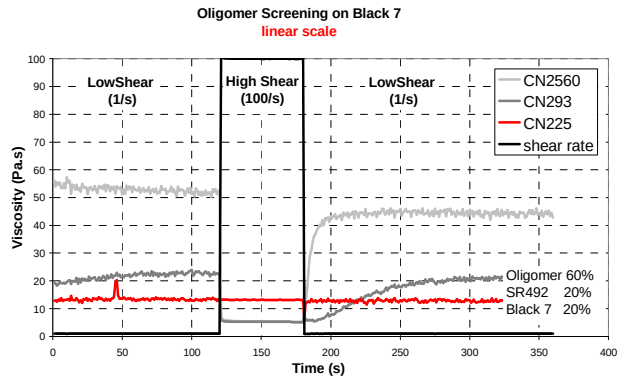
- Pigment dispersion
- The flow property
- The ink optical density
- The ink mechanical properties

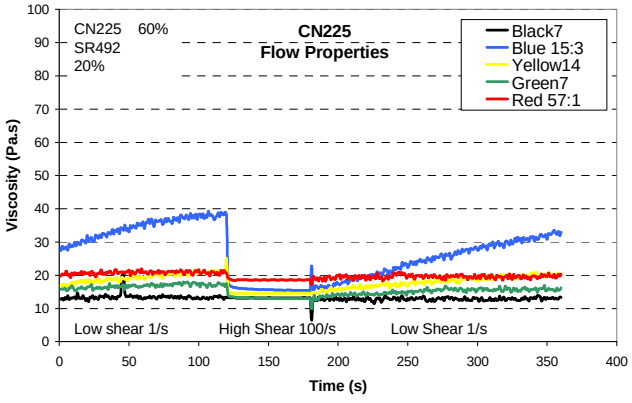
How to achieve pigment wetting ?

Over the past few years Sartomer has been studying the behaviour of oligomers with a variety of pigments, the aim being to understand the structural trends providing good pigment wetting. The conclusion of this study is the development of a brand new polyester acrylate structure : **CN225**.

CN225

CN225 is an hexafunctional polyester acrylate having a viscosity of 10Pa.s at 40℃. It provides excellent pigment wetting and flow properties but also a substantial improvement of the ink chemical resistance..The graphs below give you an overview of the flow improvement this new polyester can provide compared to standard oligomers used in flexo such as CN293 or CN2560 but also with different pigments.





There are also many other oligomers available for UV-Flexo :

- *Grinding vehicles*

CN293 – Hexafunctional Polyester Acrylate
- Low viscosity
- Fast curing
- Good pigment wetting

CN2560 – Polyester Acrylate
- Low viscosity
- Good pigment wetting
- Improve gloss

CN186 – Modified Epoxy Acrylate
- Excellent pigment wetting
- Improve flow properties

- *Adhesion*

As mentioned in the monomer section, one way to achieve adhesion is to use a high molecular weight and low Tg oligomer. Among the various adhesion promoting oligomers available from Sartomer is **CN820.**

CN820 – Acrylic Acrylate
- Adhesion to difficult plastic substrate
- Mw = 11000 g/mol
- Tg = 11℃

Recommended use : 5-10% of the formulation

- *Amine Modified Materials*

Amine modified material can in some case be a easy way to achieve properties such as :

- Surface cure improvement
- Surface leveling → gloss
- Scratch resistance
- Chemical resistance

CN554 – Amine Modified Polyether Acrylate
- Excellent Chemical resistance
- Sratch resistance
- Good adhesion

CN501 - Amine Modified Polyether Acrylate
- Low viscosity
- Fast curing

All the products mentioned in this bulletin are recommended for UV curable flexographic inks.

Sartomer has a wide portfolio of monomers and oligomers which are not mentioned in this paper, do not hesitate to ask for a complete brochure or product selector at :

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