INX...

Solutions

In a world of many inks, there is only one INX.

UV Ink Adhesion and Flexibility for 3-Piece Metal Decorating

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Outline

I. Background / Objective
II. Evaluation of Ink Adhesion & Flexibility
III. Conclusions

Background / Objective

Printers are constantly streamlining their processes

Inks can be formulated to help printers reduce the time required to run a job

UV is more efficient than thermal drying

Background / Objective

Objective: Development of UV inks which satisfy customer demands

1. Wider window for compatibility with coated substrates

2. UV ink consolidation for all applications

1. Ink Adhesion

1) Ink To Size Adhesion

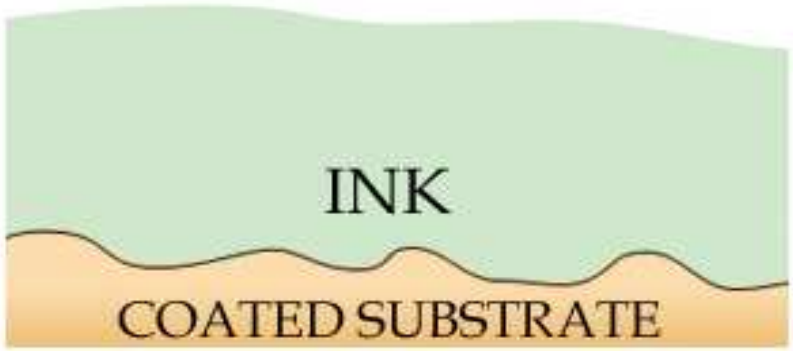
- Adhesion is an important property of any ink
- Key: maintain the bonding between ink and size coating
- Factors for adhesion:
  - 1-1) Ink laydown
  - 1-2) Surface tension
  - 1-3) Crosslink density of the ink
- Test Method: ASTM D3359-02 (adhesion to metallic substrates)

1-1) Ink Laydown

Key: Maintain the bonding between ink and coated substrate

It is necessary to have good ink lay down on the coated substrate to form an even film

GOOD INK LAYDOWN



POOR INK LAYDOWN

1-2) Surface Tension

Necessary for the surface tension of the ink formulation to match that of the size coating

	Surface Tension (dynes/cm)
Size & WBC	32 - 38
Conventional ink	30 - 32
UV ink	36 - 38

1-3) Crosslink Density

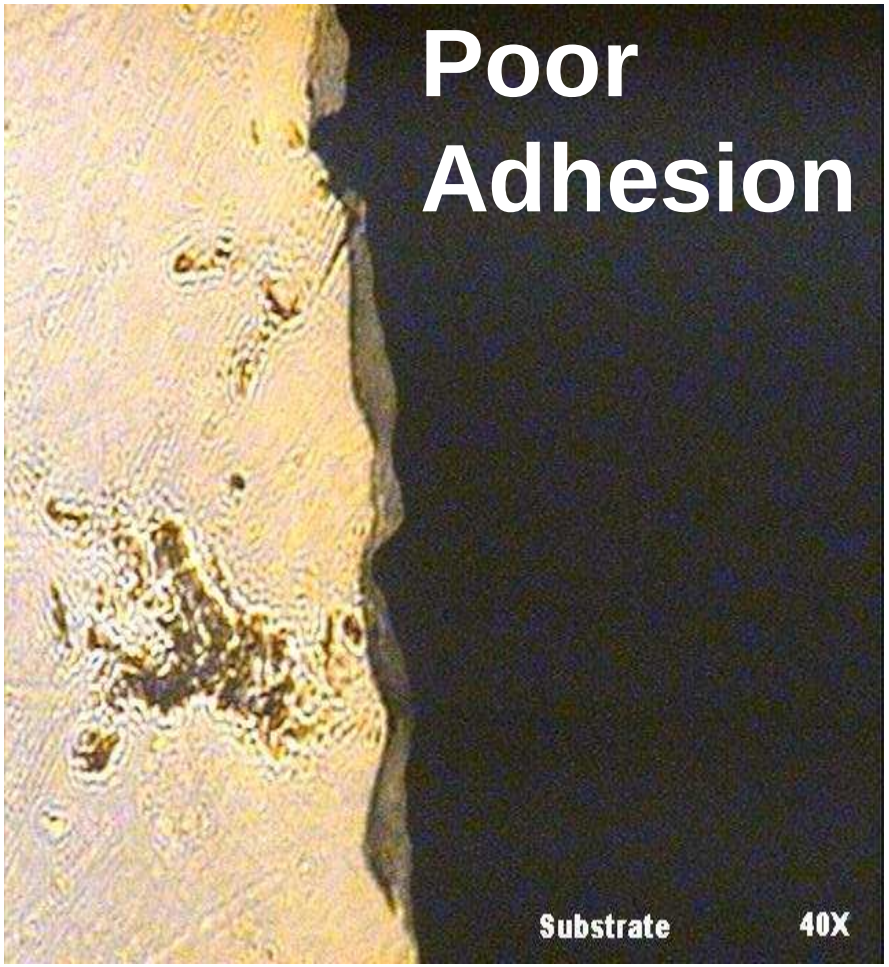
- Chemical bonds within UV cured ink are stronger than bonds between ink and coated substrate

Therefore:

- If crosslink density is too high, the amount of film shrinkage will also be high causing poor adhesion

- However if too low, adhesion can also be poor

Which ink has poor adhesion?



Inter-coat Adhesion

- Adhesion between multiple layers of ink
- Inks with high crosslink density at the surface are less receptive to subsequent prints

Other Contributors To Poor Adhesion

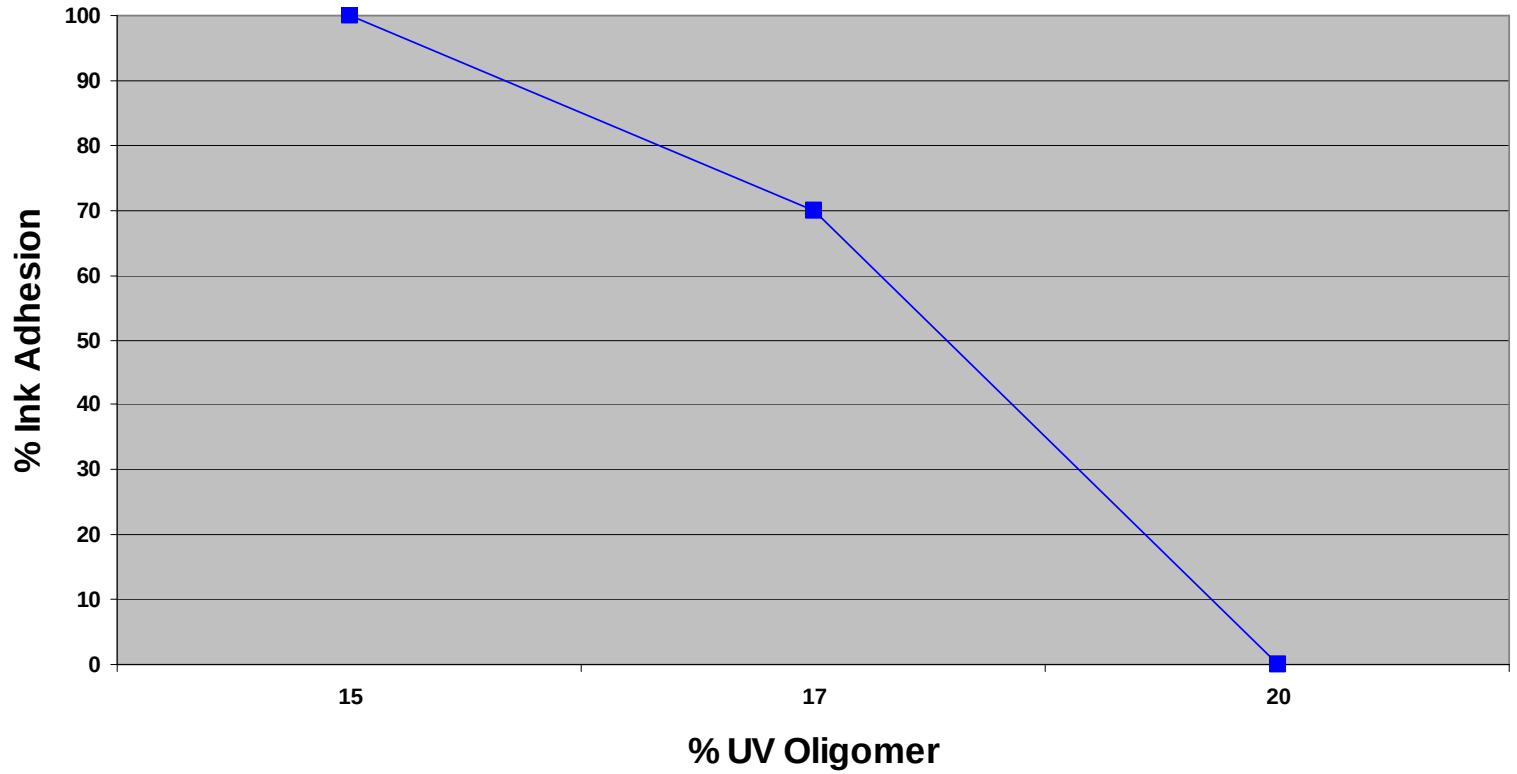
Cure Related

- Low crosslink density
- Ink film too thick

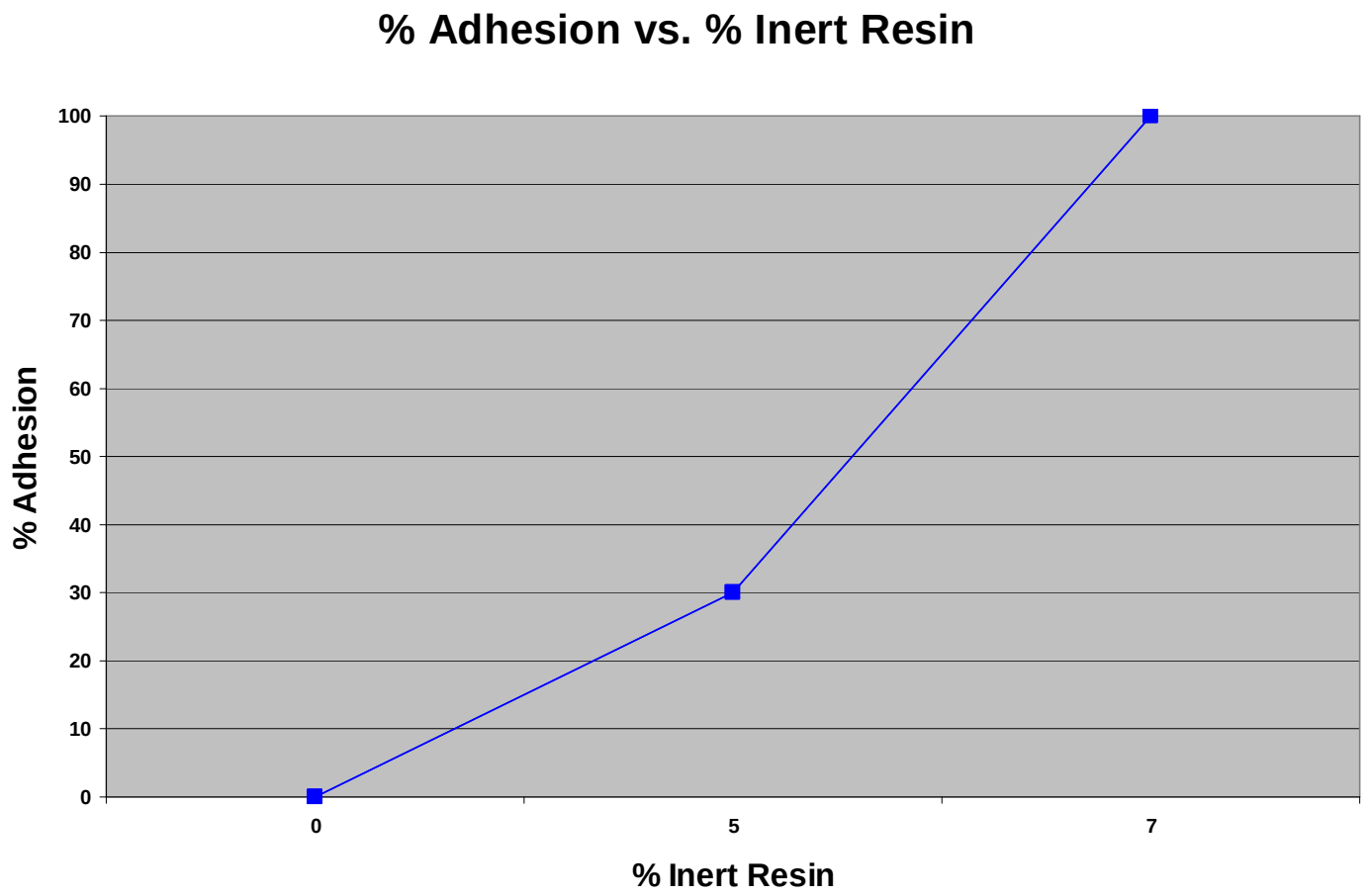
Others

- Poor ink and fountain water balance (ink over emulsified)
- Surface contamination

Data From Adhesion Evaluation



Data From Adhesion Evaluation



Conclusion From Adhesion Evaluation

For good adhesion the ink must be formulated to have optimum crosslink density and cure speed

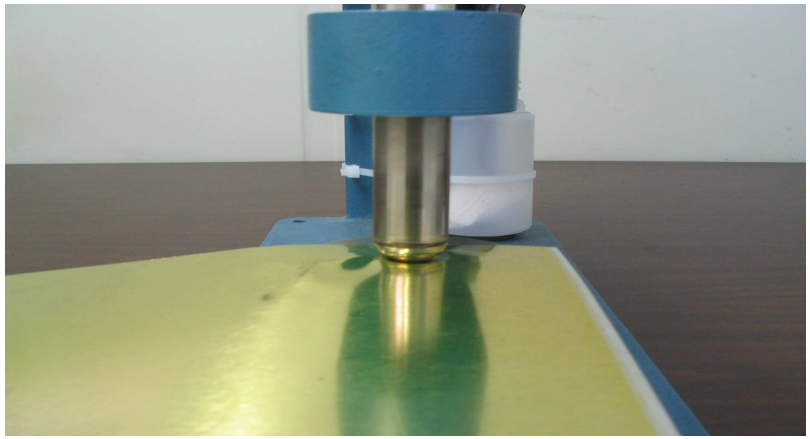
2. Ink Flexibility

2) Ink Flexibility

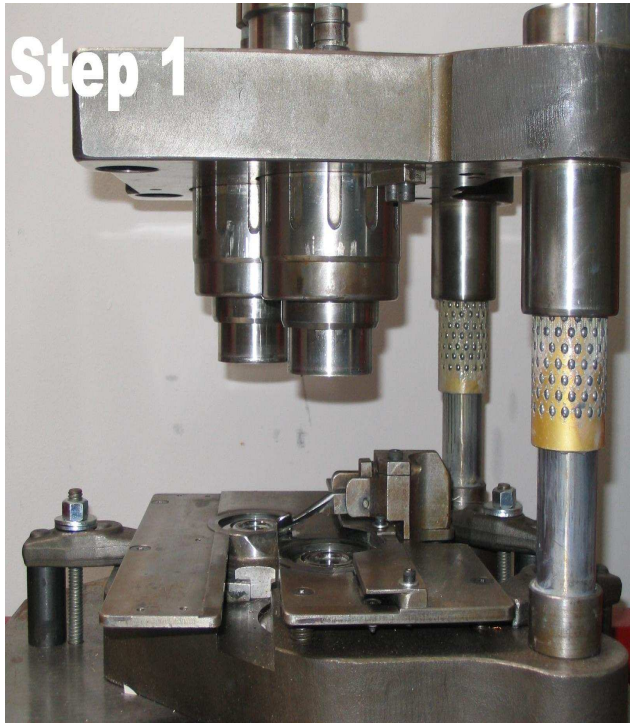
- Key: Good gloss and texture in fabricated areas
  -Crowns, closures, shaped cans etc…

- Factor of ink flexibility:
  2-1) High Shrinkage (= high crosslink density)

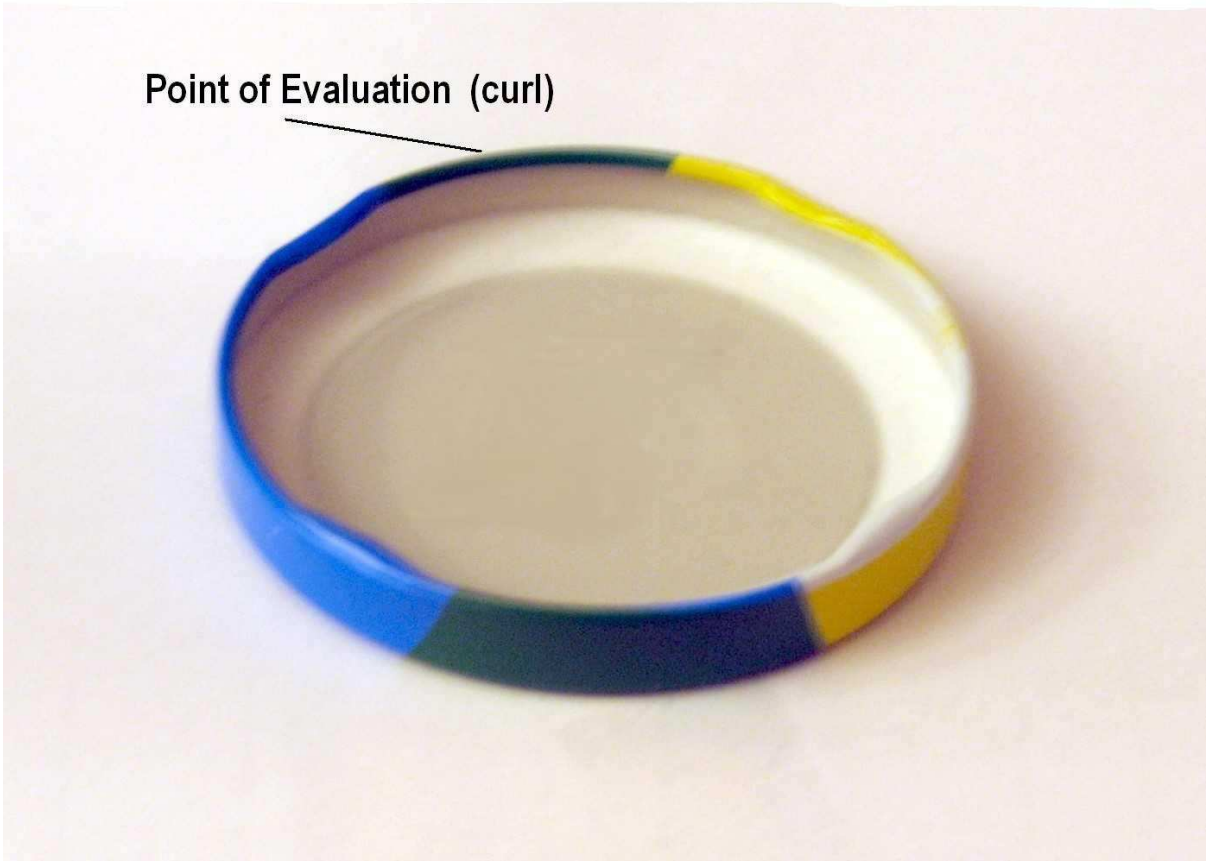
Test Methods For Flexibility (Impact Resistance)



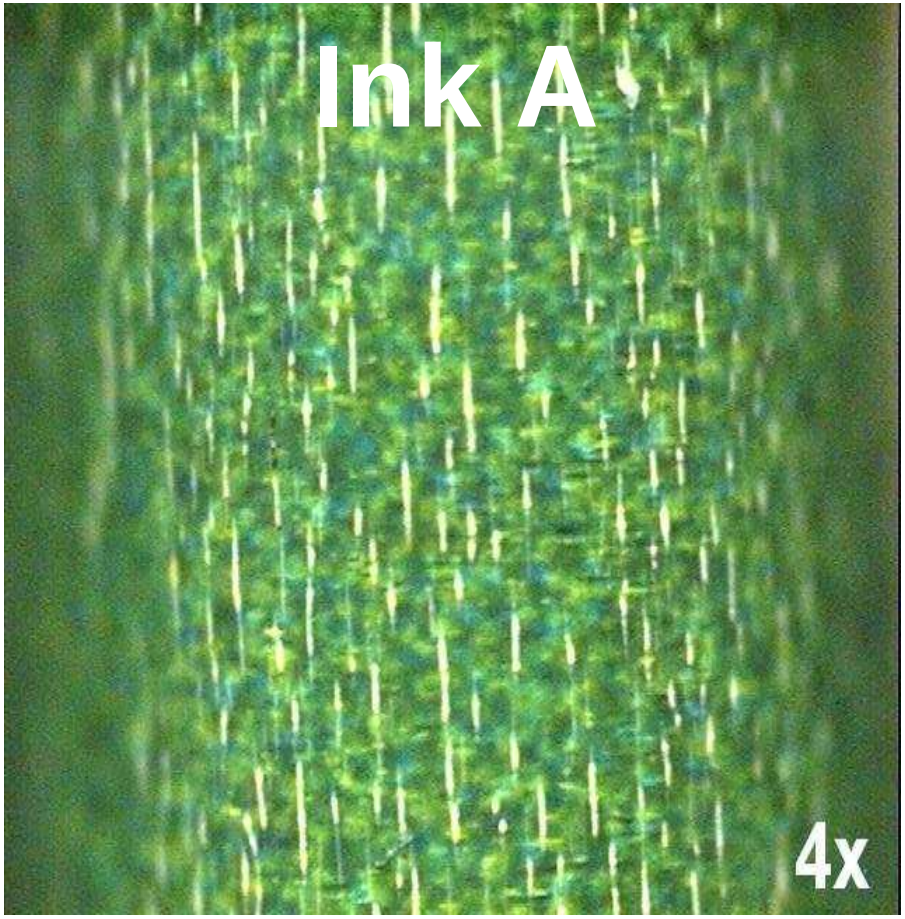
Test Methods For Flexibility (Cap Maker)

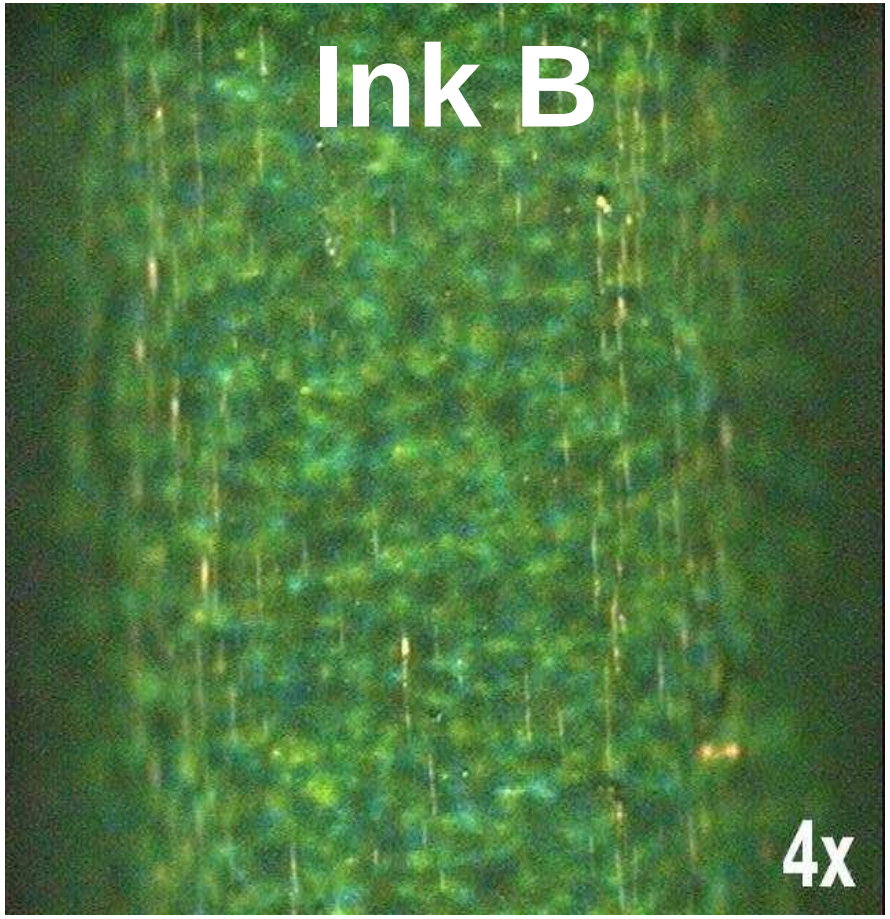


Test Methods For Flexibility



Gloss and Texture

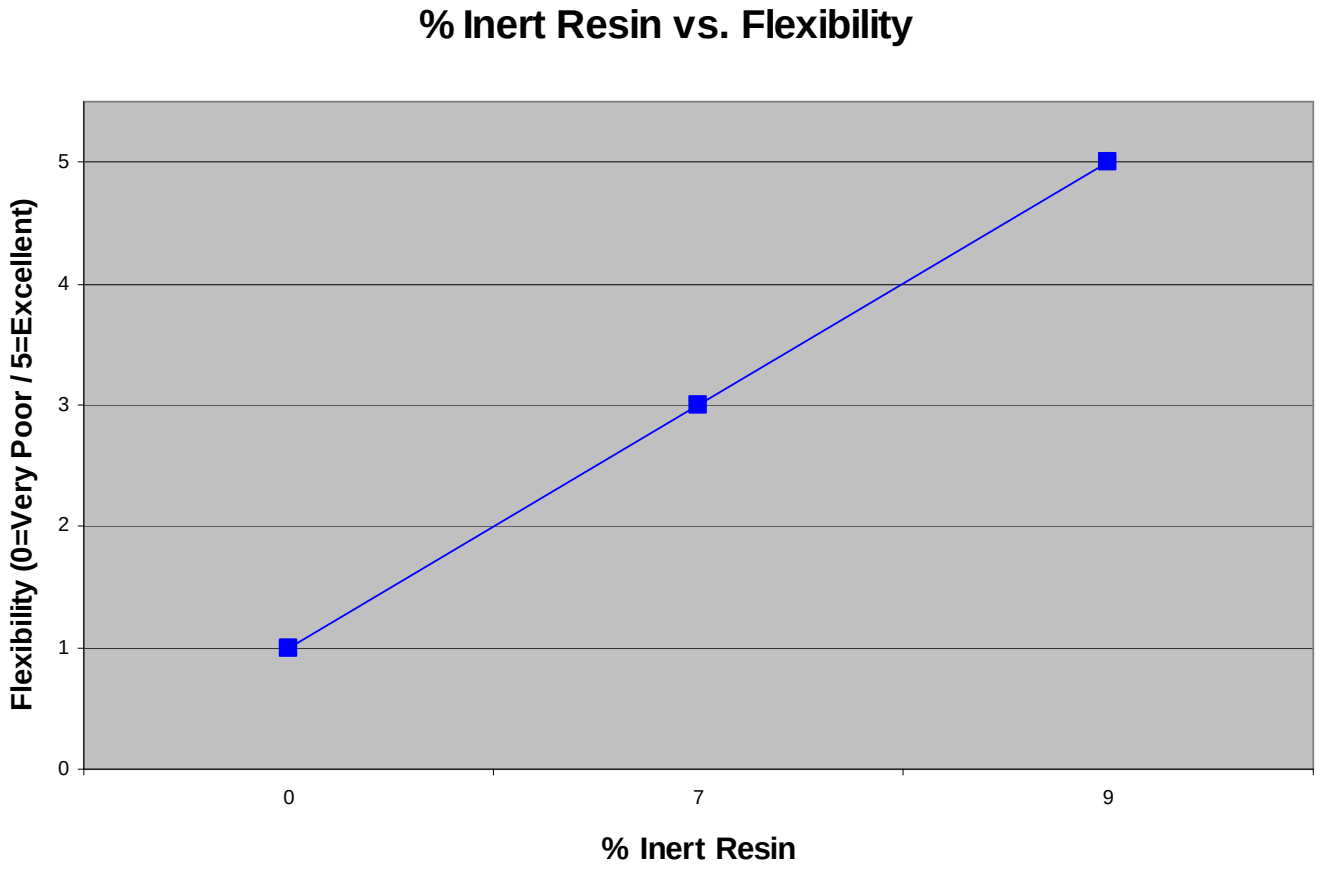




Flexibility Study

Ink A (High Crosslink Density)		Ink B (Low Crosslink Density)	
Material	**%**	**Material**	**%**
Hexafunctional Oligomer	50	Hexafunctional Oligomer	20
		Difunctional Oligomer	20
		Inert Resin	10
Trifunctional Monomer	10	Difunctional Monomer	10
Pigment & Dry Material	30	Pigment & Dry Material	30
Photoinitiator X	10	Photoinitiator X	10
Total	100	Total	100

2-1) Data From Flexibility Evaluation



2-1) Data From Flexibility Evaluation (Monomer Shrinkage %)

Monomer	Shrinkage %
Trimethylopropane triacrylate (TMPTA)	26*
Ethoxylated TMPTA	24*
Propoxylated TMPTA	15*
1,6-Hexanediol diacrylate (HDDA)	14*
Tetraethyleneglycol dimethacrylate (TEGDA)	9*

*Davidson Steven, Exploring the Science, Technology and Applications of U.V and E.B. Curing p161

Conclusion For Flexibility

For good ink flexibility low crosslink density is better, however you must also consider cure speed

Final Conclusion
(Formulating a 3-Piece UV Ink)

- For good adhesion the ink must be formulated to have optimum crosslink density
- Low crosslink density is good for flexibility
- However too low a crosslink density will have slow cure speed
- By carefully selecting raw materials a proper balance of good cure with minimal ink film shrinkage can be achieved

New 3-Piece UV Ink System

- Wider window for adhesion on all sizes and coatings
- Good cure and minimal film shrinkage
- Improved ink flexibility for all applications

Thank you for your time