Qualipoly Chemical Corp.

High Performance UV-Cured Enamels for Can Coatings Primer

Presented by

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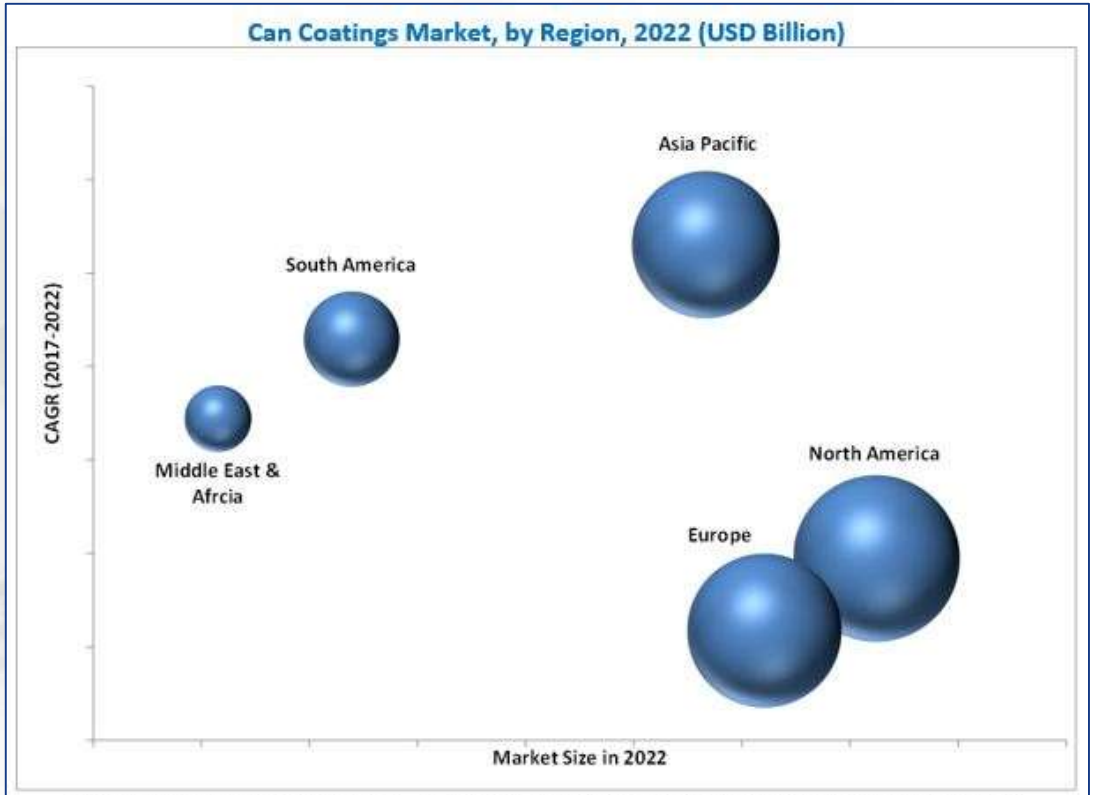
RADTECH UV+EB 2020

Market Overview

North America was the largest market for can coatings, in terms of value and volume, in 2016

The global can coatings market was estimated at USD 1.91 Billion in 2017 and was projected to reach USD 2.27 Billion by 2022, at a CAGR of 3.4% between 2017 and 2022.



Source: Secondary Research, Expert Interviews, and Marketsandmarkets Analysis

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Outline

A. Introduction

B. Experimental

C. Results and Discussion

D. Conclusion

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Introduction

➢ Current Metal Coating Industry Status

- **Predominantly Traditional Baked coatings.**
  - ✓ **Excellent adhesion**
  - ✓ **Mechanical and resistance properties**
  - ✓ **Adhesion on metal substrates (Tin-plate, TFS etc)**

Inner coating

Epoxy phenolic resins

Outer primer

Polyester and amino resins.

Top coat(the varnish)

Acrylic and amino resin.

Ink

~ 70% UV cure
~ 30% baked

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Introduction

➢ concerns

- **Environmental issues**
  - **Solvents (VOCs)**

- **Policy restrictions**
  - **Surface coating of cans is one of the largest industrial operations identified as sources of VOC / HAPs and is regulated by U.S. EPA CAA (40 CFR part 63 – see statement 20th Dec 2019)**
  - **Trend is global - By 2020, China is projected to reduce VOC emission by 50% compared to 2016.**

- **Energy consumption**
  - **Baking ovens use more energy.**

    More energy consumption = More cost

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Introduction

➢ Objectives

- **Target:**
  - **Develop a UV curable white coating suitable for application directly to metal**

- **Methodology:**
  - **By studying and evaluating formulation based on different combination of raw material components**

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Outline

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Experimental

➢ Preparation

Mix → **Grinding** → **Mix** → **Defoamed & Preparation done**

High-speed mixer

The three-roller mill

Supersonic oscillator

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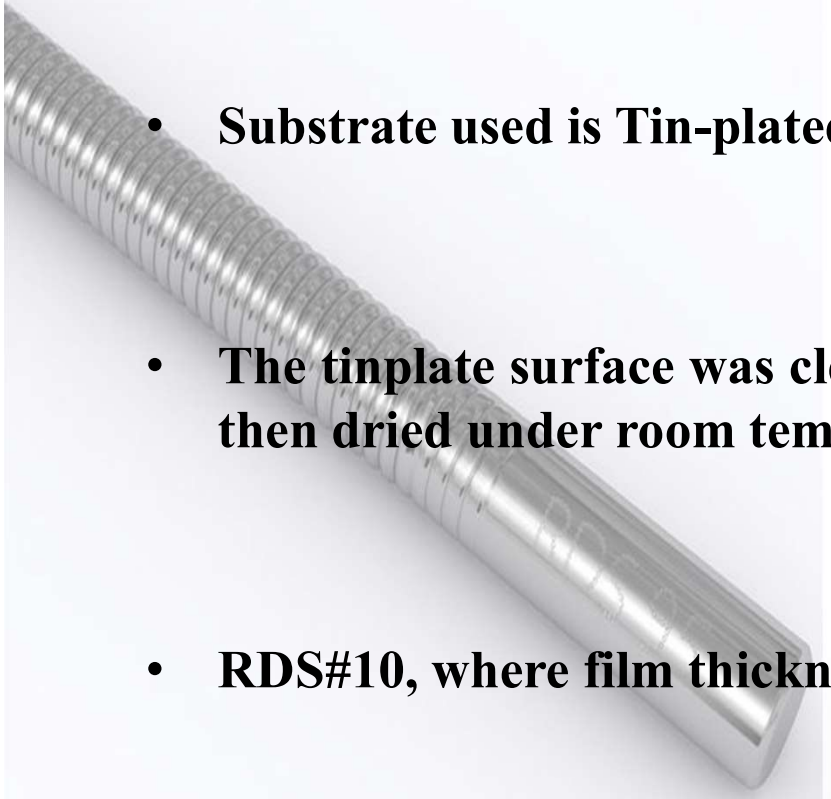
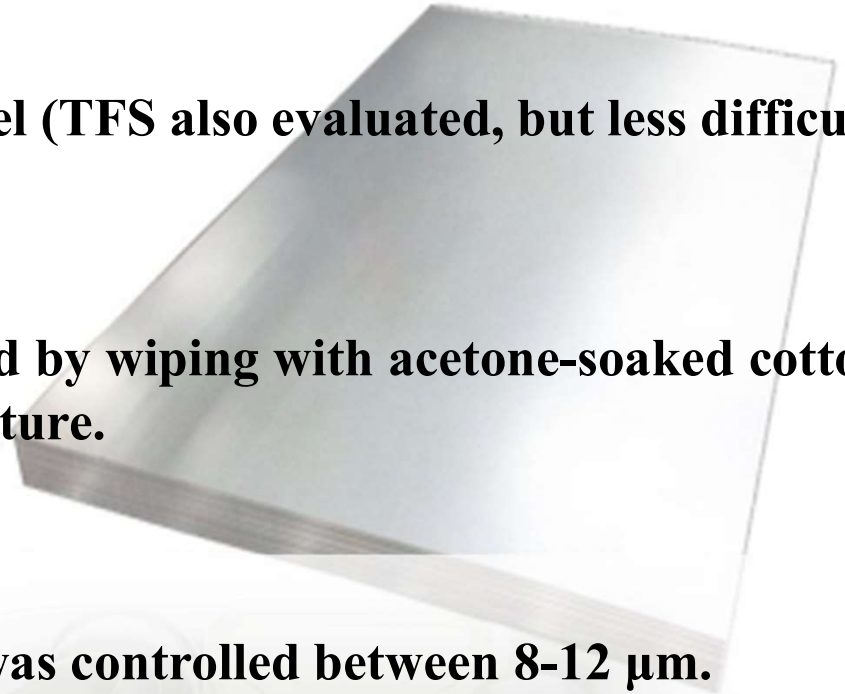
Experimental

➢Curing preparation





- **Substrate used is Tin-plated steel (TFS also evaluated, but less difficult)**
- **The tinplate surface was cleaned by wiping with acetone-soaked cotton, then dried under room temperature.**
- **RDS#10, where film thickness was controlled between 8-12 µm.**

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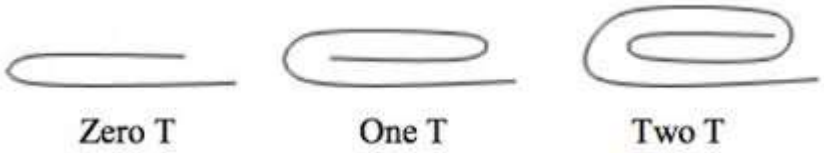
Experimental

➢ Test method & Instrument

T-bend



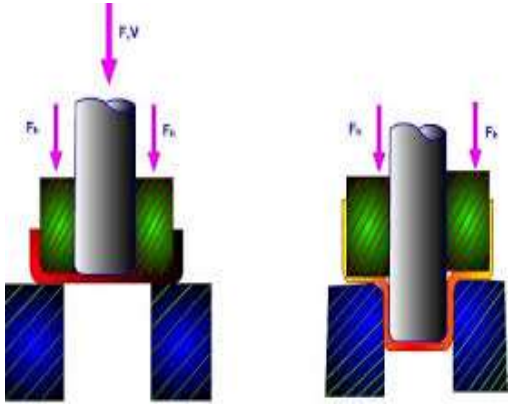
Gloss meter

Viscosity (Ford cup #4)

Hardness

Impact resistance

Drawing test



Adhesion

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Outline

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Results and Discussion

➢Resin - The oligomers

QualiCure™	GU8987Q	GU8365Q	GU1280Q	GU1900Z	GU3030Z	GA3000Z
Resin Type	Polyester acrylate	Polyester acrylate	Modified flexible Epoxy acrylate	Modified Epoxy acrylate	Urethane acrylate	Urethane acrylate
Functionality	1	2	2	2	2	2
Feature	• Pigment wetting • Adhesion	• Pigment wetting • Adhesion	• Tensile strength • Workability	• Flexibility	• Elongation • Workability	• Elongation • Tensile strength • Workability

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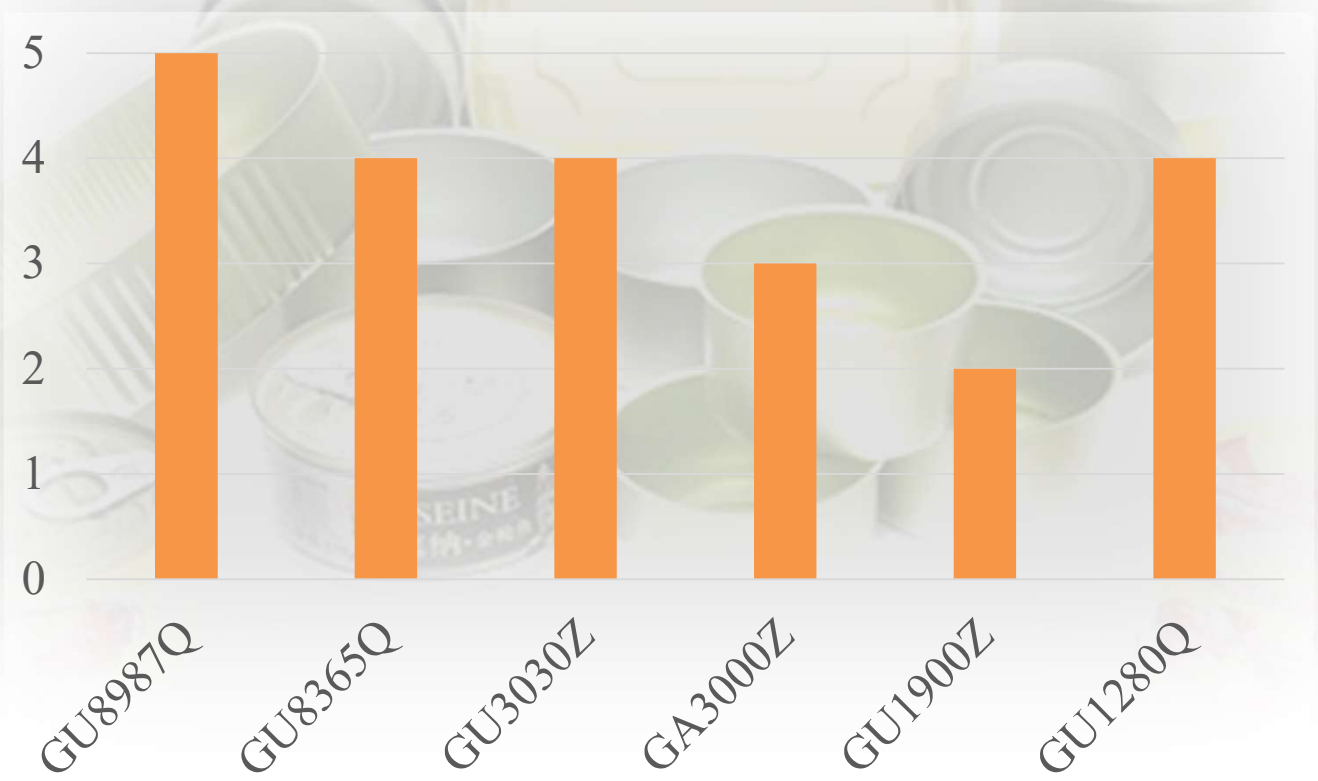
Results and Discussion

➢ Adhesion Comparison



The degree of adhesion (0B-5B). The formula consists of 95% oligomer and 5% Omnirad 1173, coated with RDS#4 on tinplate. UV exposure was carried out under 1000mj/cm^2, 600 mw/cm^2 condition.

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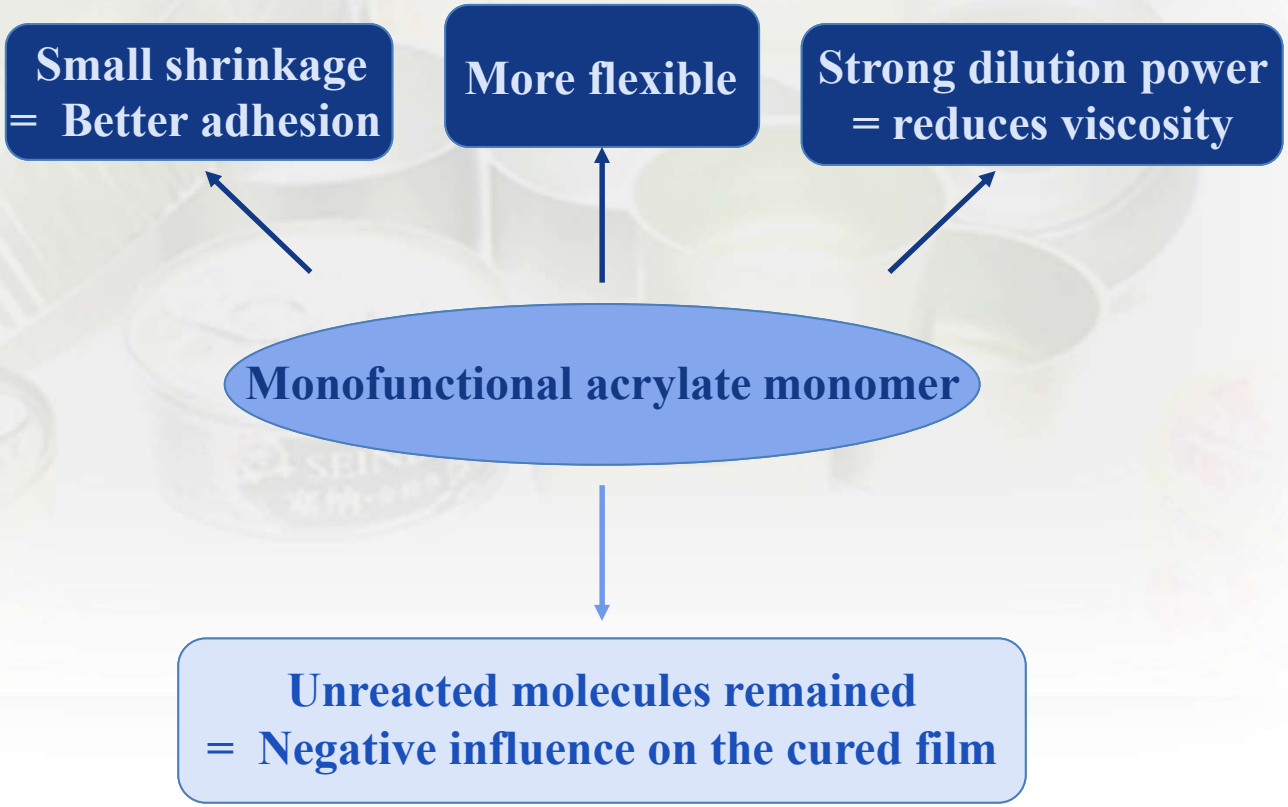
Results and Discussion

➢ Monomer Influence



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Results and Discussion

➢ Monomer Influence

Greater cross-link
= Improved toughness and chemical resistance

Di-functional & Multifunctional acrylate monomer

Alkoxylate

Less shrinkage
= Improved adhesion

Large shrinkage
= Poor adhesion

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Results and Discussion

➢ Basic Formula

Raw material	Formula (%)						
	1#	2#	3#	4#	5#	6#	7#
GU8365Q	20	20	20	20	-	-	-
GU8987Q	-	-	-	-	20	20	20
GU3030Z	20	20	20	20	20	-	-
GA3000Z	-	-	-	-	-	20	20
GU1900Z	10	10	10	10	10	10	
GU1280Q	-	-	-	-	-	-	10
CTFA	6	-	-	6	6	6	6
EOEOEA	-	6	6	-	-	-	-
DPGDA	3	3	-	-	-	-	-
NPG2PODA	-	-	3	3	3	3	3
TMP20EOTA	2	2	2	2	2	2	2

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Results and Discussion

➢ Basic Formula (Cont)

Raw material	Formula (%)						
	1#	2#	3#	4#	5#	6#	7#
Solsperse 32000	1						
BYK-3710	0.1						
BYK-088	0.4						
Dupont-R960	30						
GA2600Y	1						
ESACURE KIP160	5.5						
Omnirad 819	1						
Omnirad TPO-L	2						

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Results and Discussion

➢ Formula Comparison

Raw material	Formula (%)	
	1#	2#
GU8365Q	20	20
GU8987Q	-	-
GU3030Z	20	20
GA3000Z	-	-
GU1900Z	10	10
GU1280Q	-	-
CTFA	6	-
EOEOEA	-	6
DPGDA	3	3
NPG2PODA	-	-
TMP20EOTA	2	2

Performance	Formula	
	1#	2#
Adhesion	2B	2B
Hardness	H	H
T-Bend	2T	2T
Impact resistance	PASS	PASS
Dryness	Dry	Sticky
Viscosity (“ Ford 4 Cup)	300	300
Gloss 60º	85-90	85-90
Hiding power	Poor	Poor

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Results and Discussion

➢ Formula Comparison

Raw material	Formula (%)	
	1#	4#
GU8365Q	20	20
GU8987Q	-	-
GU3030Z	20	20
GA3000Z	-	-
GU1900Z	10	10
GU1280Q	-	-
CTFA	6	6
EOEOEA	-	-
DPGDA	3	-
NPG2PODA	-	3
TMP20EOTA	2	2

Performance	Formula	
	1#	4#
Adhesion	2B	4B
Hardness	H	F
T-Bend	2T	1T
Impact resistance	PASS	PASS
Dryness	Dry	Dry
Viscosity (“ Ford 4 Cup)	300	200
Gloss 60º	85-90	85-90
Hiding power	Poor	Fair

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Results and Discussion

➢ Formula Comparison

Raw material	Formula (%)	
	4#	5#
GU8365Q	20	-
GU8987Q	-	20
GU3030Z	20	20
GA3000Z	-	-
GU1900Z	10	10
GU1280Q	-	-
CTFA	6	6
EOEOEA	-	-
DPGDA	-	-
NPG2PODA	3	3
TMP20EOTA	2	2

Performance	Formula	
	4#	5#
Adhesion	4B	5B
Hardness	F	F
T-Bend	1T	1T
Impact resistance	PASS	PASS
Dryness	Dry	Dry
Viscosity (“ Ford 4 Cup)	200	200
Gloss 60º	85-90	90-100
Hiding power	Fair	Excellent

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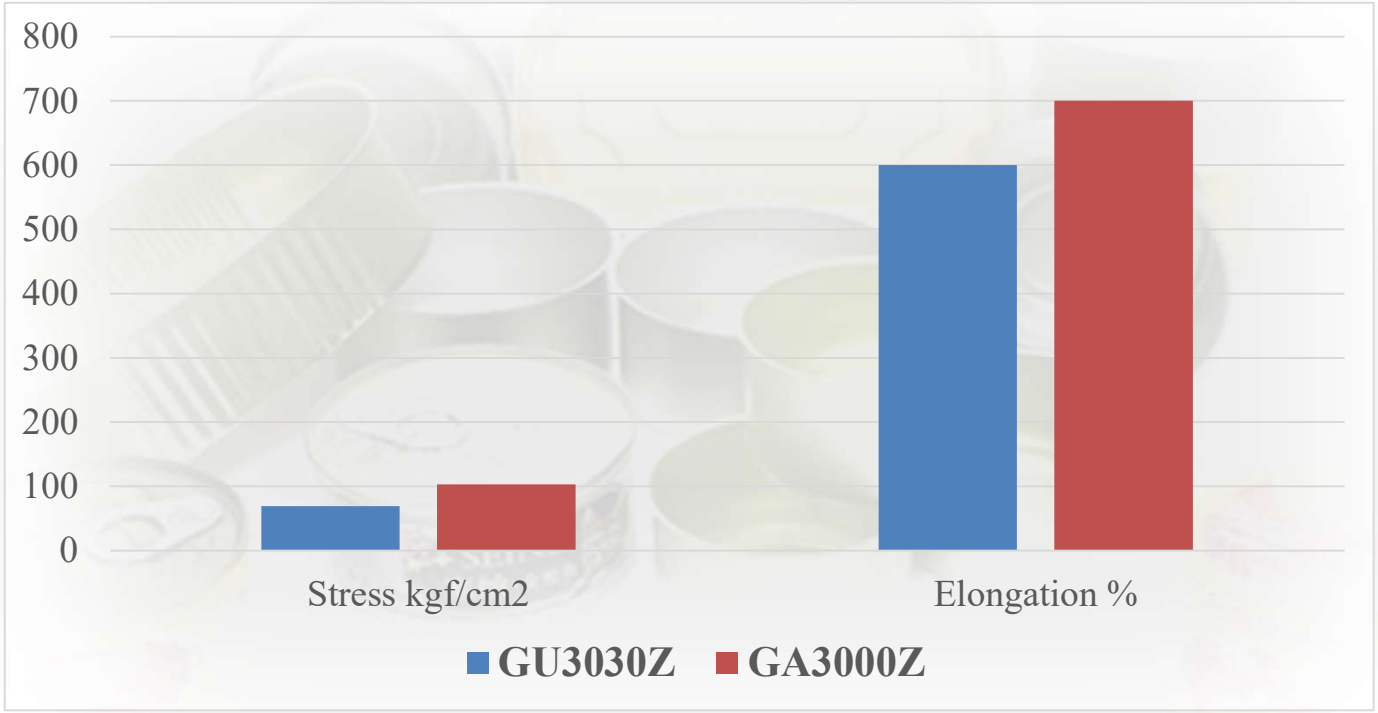
Results and Discussion

➢Tensile and elongation comparison



- **T-Bend performance could be further improved by switching to GA3000Z**

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Results and Discussion

➢ Formula Comparison

Raw material	Formula (%)	
	5#	6#
GU8365Q	-	-
GU8987Q	20	20
GU3030Z	20	-
GA3000Z	-	20
GU1900Z	10	10
GU1280Q	-	-
CTFA	6	6
EOEOEA	-	-
DPGDA	-	-
NPG2PODA	3	3
TMP20EOTA	2	2

Performance	Formula	
	5#	6#
Adhesion	5B	5B
Hardness	F	F
T-Bend	1T	0T
Impact resistance	PASS	PASS
Dryness	Dry	Dry
Viscosity (“ Ford 4 Cup)	200	200
Gloss 60º	90-100	90-100
Hiding power	Excellent	Excellent

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Results and Discussion

➢ Formula Comparison

Raw material	Formula (%)	
	6#	7#
GU8365Q	-	-
GU8987Q	20	20
GU3030Z	-	-
GA3000Z	20	20
GU1900Z	10	-
GU1280Q		10
CTFA	6	6
EOEOEA	-	-
DPGDA	-	-
NPG2PODA	3	3
TMP20EOTA	2	2

Performance	Formula	
	6#	7#
Adhesion	5B	5B
Hardness	F	H
T-Bend	0T	0T
Impact resistance	PASS	PASS
Dryness	Dry	Dry
Viscosity (“ Ford 4 Cup)	200	150
Gloss 60º	90-100	90-100
Hiding power	Excellent	Excellent

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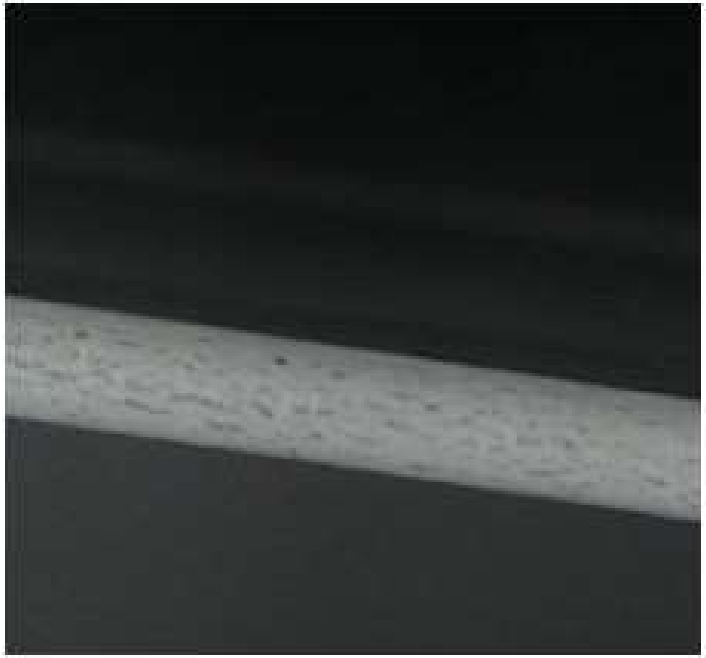
Results and Discussion

- **10x Microscopic enlargement of the bended wedge in the T-Bend test of formula 7#(left) and formula 5#(right).**

Intact (left)



Fractured (right)

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Results and Discussion

➢ Influence of Titanium Dioxide (TiO_2) Addition

Performance	The ratio of Titanium Dioxide addition			
	25%	30%	35%	40%
Adhesion	5B	**5B**	5B	4B
T-Bend	0T	**0T**	0T	1T
Viscosity(second)	120	**150**	200	300
Hiding power	Poor	**Excellent**	Excellent	Excellent

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Results and Discussion

➢ Influence of Surface Tension - Dyne Value

UV ink performance on the white coating	Surface dyne value (dyne) of white coating		
	Below 30	31-35	**36-40**
Adhesion	3B-4B	4B-5B	**5B**
Leveling	Poor	Excellent	**Excellent**

- **The dyne value of formula 7# is 38.**

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Results and Discussion

➢ Photo-Initiator Selection

(Surface curing type, short wavelength-UVB, UVC)

Performance	Photo-initiator			
	Omnirad 1173	Omnirad BP	Omnirad 184	Esacure KIP-160
Yellowing	Moderate	High	Moderate	**Low**
Odor	High	Low	Moderate	**Low**
Curing efficiency	High	High	Moderate	**Moderate**

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Results and Discussion

➢ Photo-Initiator Selection

(Deep curing type, long wavelength-UVA)

Performance	Photo-initiator			
	Omnirad 819	**Omnirad TPO-L**	Omnirad 907	Omnirad ITX
Yellowing	Low	Low	High	High
Odor	Low	Low	High	Moderate
Curing efficiency	High	Moderate	High	Very high
Solubility	**Poor**	**Good**	Good	Good

- **Due to the poor solubility of Omnirad 819, the best selection will be the combination of Omnirad 819 and Omnirad TPO-L**

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Results and Discussion

➢ Machinability (draw process) of Formula 7#

1 cm drawing depth for round lid (left) and 2 cm drawing depth for square lid (right).

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Results and Discussion

➢ Machinability (draw process) of Formula 7#

1 cm drawing depth for keyhole type followed by steam cooking (121℃, 1 h).

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Conclusion

- A feasible UV formula for white coating enamel has been rationally designed, enables lower energy consumption
- Other metal substrates are applicable e.g. aluminum
- Future direction includes a better machinability e.g. up to 5 cm drawing depth

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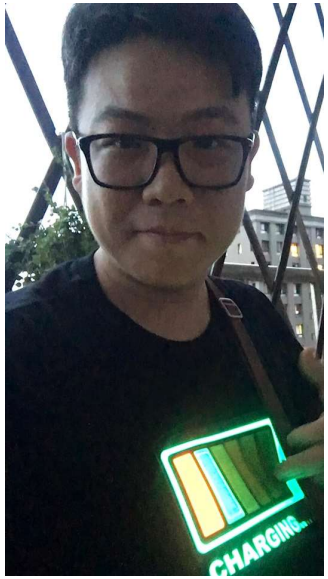
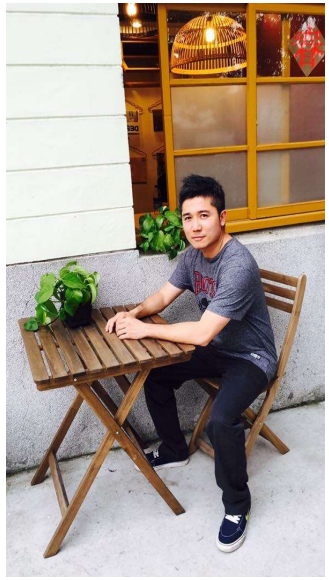
Acknowledgement

James Tian



Herman Wang



Dr. Isaac Ho

Luxsit Ltd

Qualipoly Chemical Corp.

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Thanks for your participation

Enjoy the Conference reception

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