High Performance Keyboard Coatings

Aneta Bogdanova and Rick Longo,

Performance Coatings International Laboratories, USA

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Need of Protective Coatings

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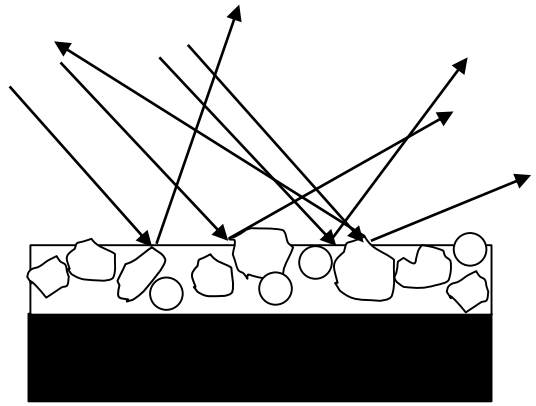
Keyboard Coatings Challenges

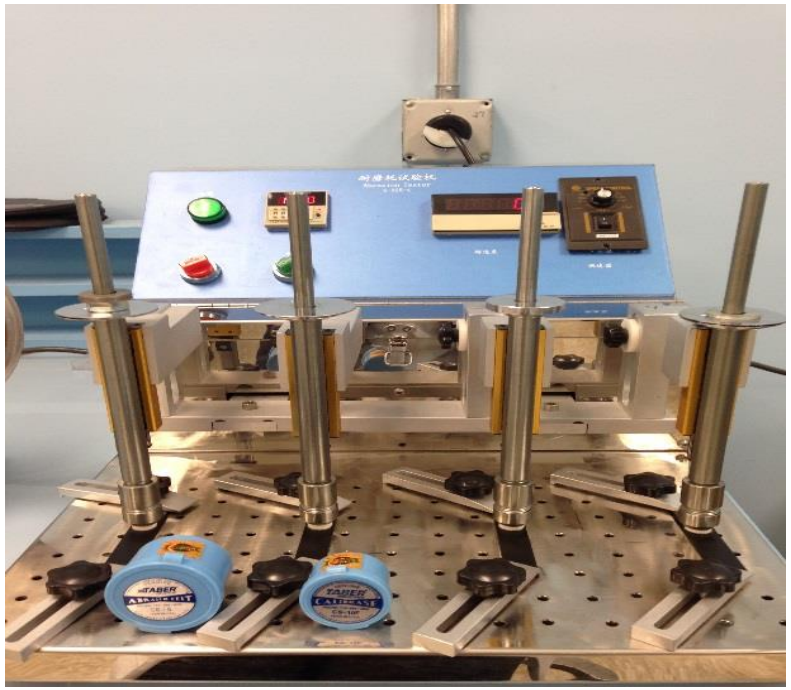
- Reduce Key Cap Wear with Continuous Long Term Usage
- Meet Demanding Customer Specifications
- Fight Workplace Germs
- Comply with International Health, Safety & Environmental Requirements
- Competitive Prices

Gloss Reduction



matted surface

Wear Resistance



Key Wear Durability
CS-5 Wearaser, 200g load, 38 mm stroke, 250 000 cycles

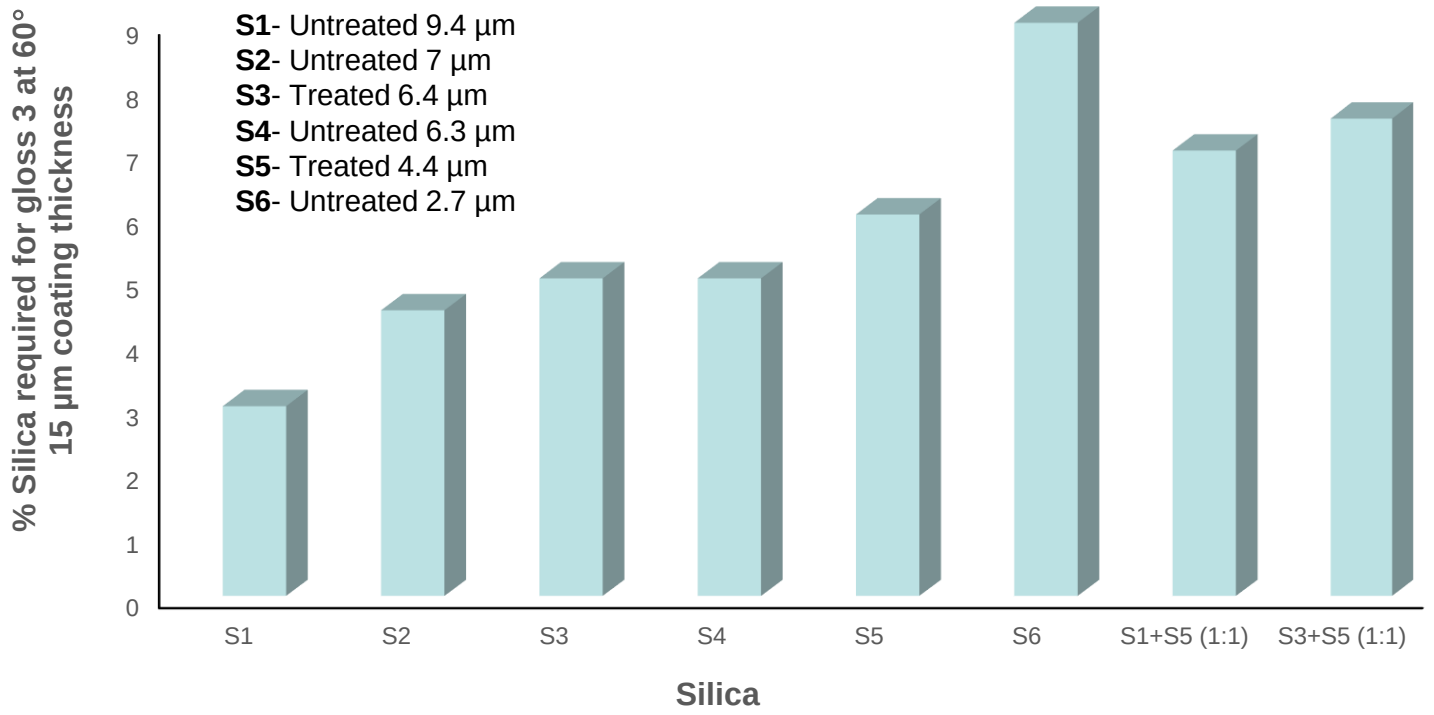
Legend Abrasion
CS-10F Wearaser, 500g load, 9.5 mm stroke, 1250 cycles

Gloss Reduction

- Silica Particles
- Minerals
- Organic Particles
- Waxes
- Self-matting Resins

MODEL UV SYSTEM	%
Multifunctional Acrylates	30
Rheology modifier	2
Flow Additive	0.4
Initiator	1.3
Solvents	66.3

Gloss Reduction with Silica



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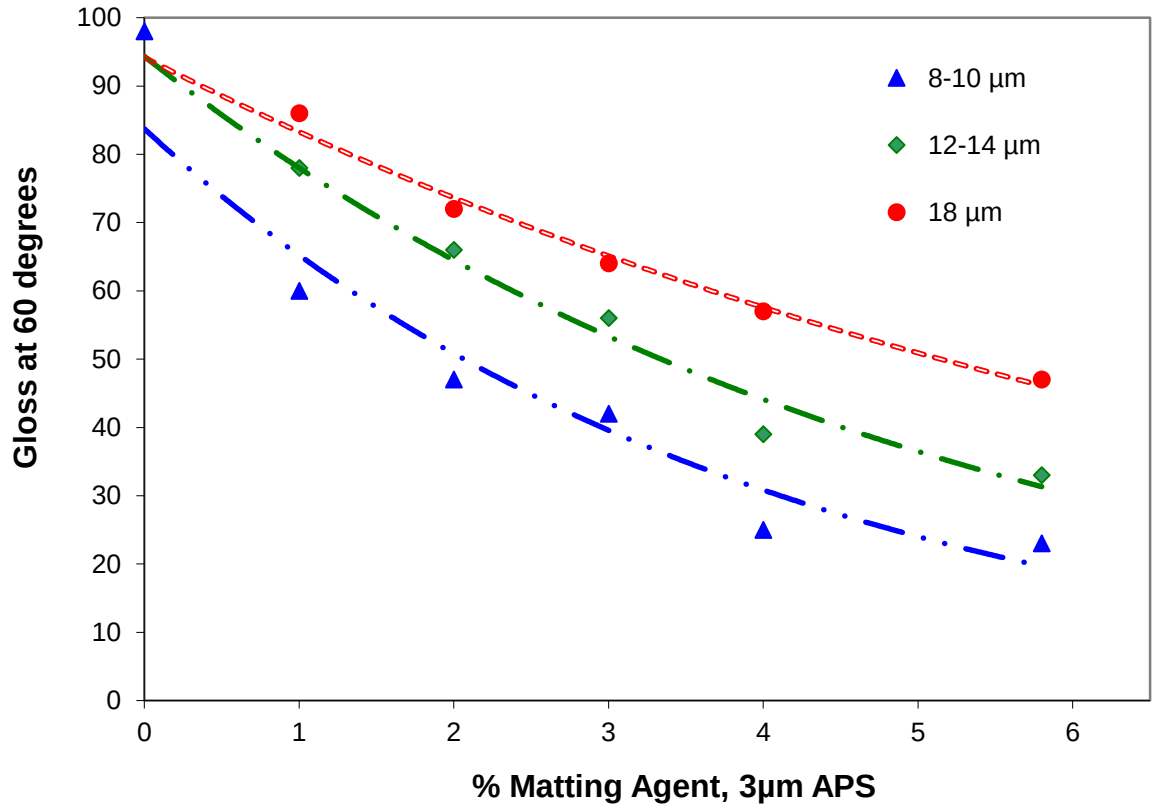
Gloss Reduction - Coating Thickness Dependence



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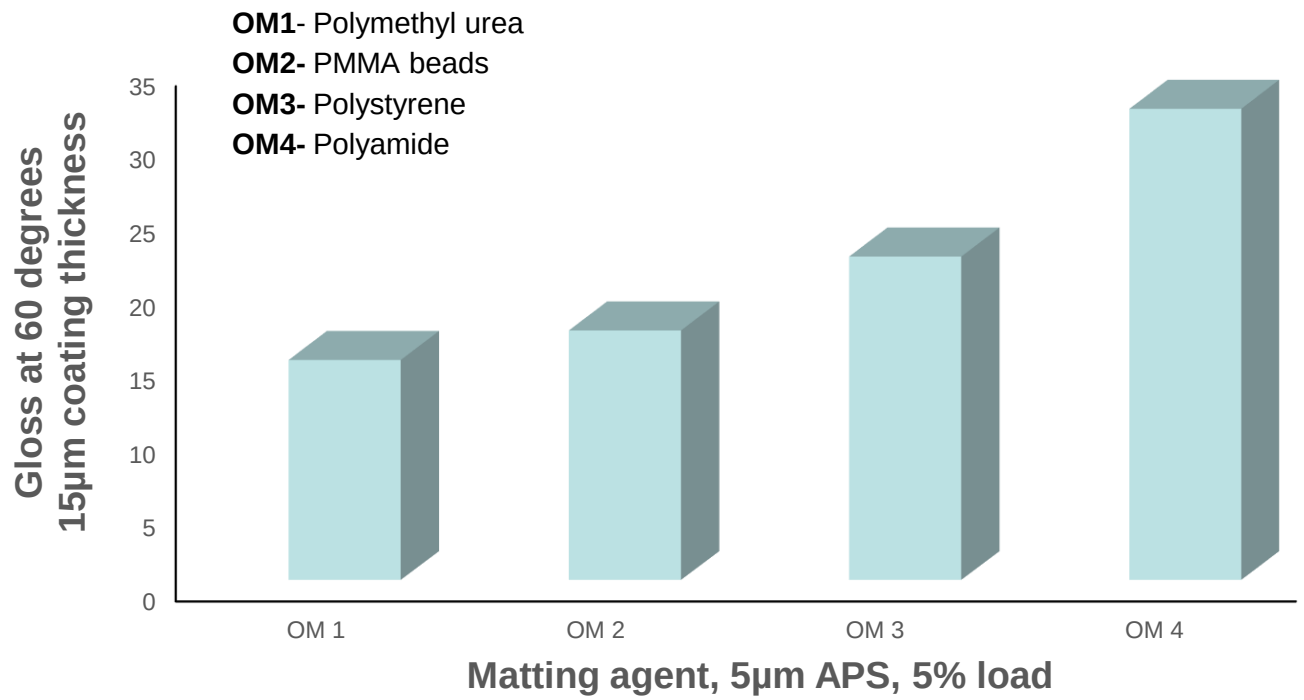
Gloss Reduction with Organic Particles



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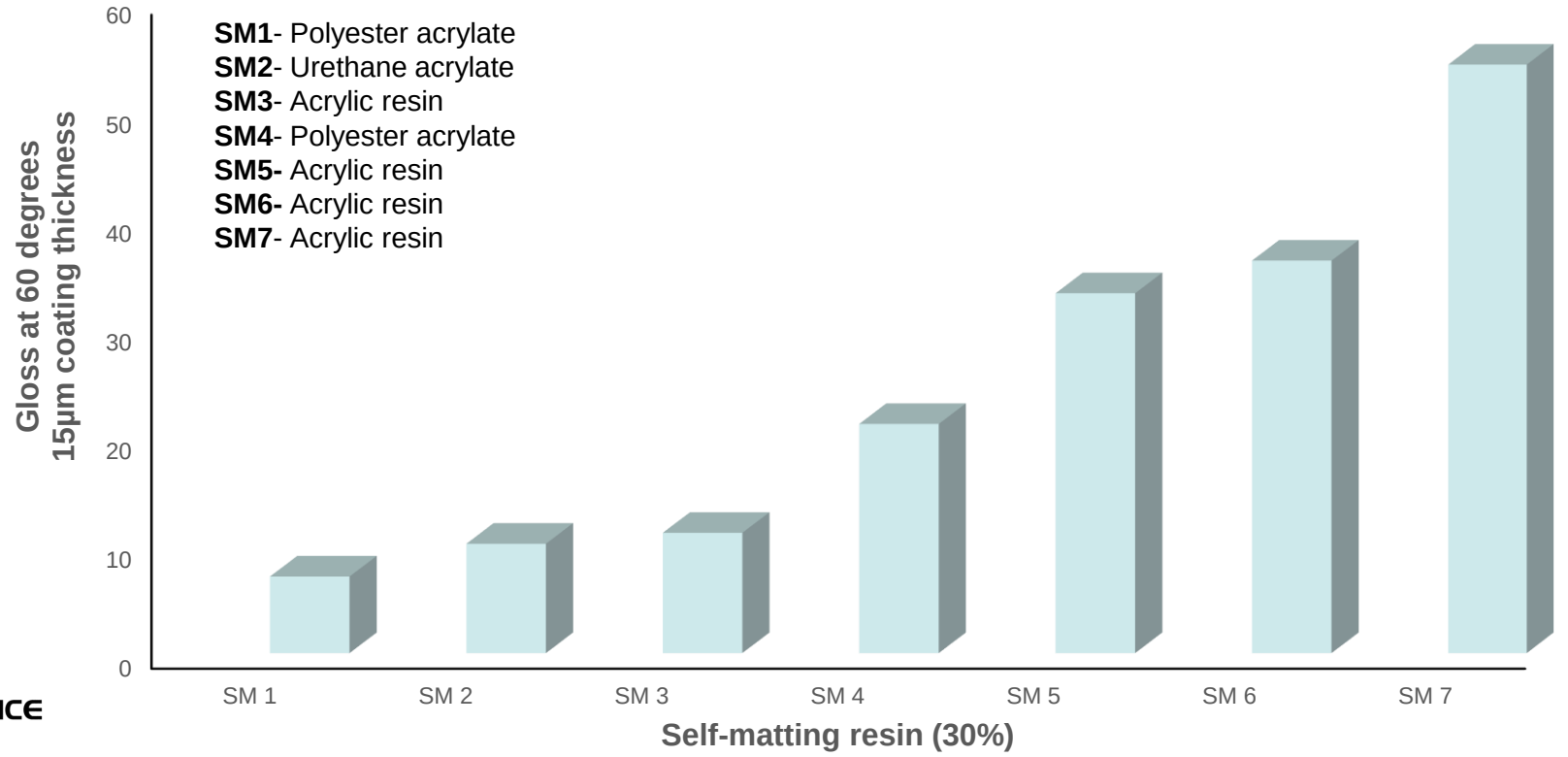
Gloss Reduction

- Mineral fillers- kaolin, cristobalite, calcium carbonate, ceramic microspheres
  - Not significant wear resistance
  - Effect on opacity
  - Increased pencil hardness with ceramic microspheres
- Waxes - polyethylene, polypropylene, amide, PTFE

  - Significant improvement of surface properties

Gloss Reduction with Self-matting Resins



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Gloss Reduction Using Different Resins

Type of resin in solvent borne anti-glare formulation	60° Gloss at 8 µm coating thickness on polycarbonate	Taber[a] 100 cycles	Taber[a] 500 cycles	Pencil Hardness[b]
Multifunctional acrylate	15	2.3	9.4	H
Polyether acrylate	13	3.2	7.0	H
Polyurethane acrylate	15	2.8	8.5	H
Silica nanocomposite in acrylate/ multifunctional acrylate (1:1)	5	1.8	2.3	H

[a]ASTM D-1044, CS-10 wheels, 500g load @ 100 and 500 cycles %Δ – Haze – PC data
[b]ASTM D-3363, 750 grams @ Mitsu-Bishi Hi Uni pencils – PC data

High Performance Keyboard Coatings

Coating	Chemistry	Matting Effect	Uses
Coating 1	Nanocomposite/Acrylates	Silica, wax	Premium Non-textured material Optimal coating thickness - 8µm
Coating 2	Urethane Acrylate – self-matting	Self-matting, silica	Smooth and textured material Smooth finish Thickness 15µm
Coating 3	Acrylates	Silica	Smooth and textured material Cost effective Ease to control gloss Thickness 12µm

High Performance Keyboard Coatings

	Coating 1	Coating 2	Coating 3
Adhesion[a]	100%	100%	100%
Gloss[b]	5	3	3
Coating Thickness[c], µm	8	15	12
Legend Test[d]	pass	pass	pass
Wear Resistance[d]	>250,000	250,000	250,000
RCA[e]	>150	150	150
Pencil Hardness[f]	1 H	1 H	1 H
Steel Wool Scratch[g], psi	24	5	32

[a] ASTM D-3359
[b] ASTM D 523
[c] Measured with micrometer
[d] Described earlier
[e] ASTM F-2357
[f] ASTM D 3363 750g load, Mitsu-Bishi Hi Uni pencils, ABS
[g] Rotary test representing scratching using #0000 steel wool pad at load @5 rotations. (No scratches at load) – PC data

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Resistance to Common Products

Product	Resistance of Coatings 1,2 and 3
Coffee	A
Diet Pepsi®	A
Windex®	A
Hand Soap	A
Chlorox®	A
Fantastic® Cleaner	A
Sunscreen	A
Hand Cream	A
Ketchup	A
Mustard	A

A-Superior Resistance, Long Term Contact (>24 hours)

B-Excellent Resistance, Contact up to 8 hours

C-Good Resistance, Contact up to 1 hour

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Chemical Resistance

Chemical Resistance	Uncoated ABS	Coating 1	Coating 2	Coating 3
Gasoline	C	A	A	A
Acetone	C	B	B	B
Methyl Ethyl Ketone	C	B	B	B
Propyl Alcohol	A	A	A	A
Toluene	C	A	A	A
Ethyl Alcohol	A	A	A	A
Sulfuric Acid (10%)	A	A	A	A
Sodium hydroxide10% (10%)	C	B	B	A

A-Superior Resistance, Long Term Contact (>24 hours)

B-Excellent Resistance, Contact up to 8 hours

C-Good Resistance, Contact up to 1 hour

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Environmental Test Results

Test	Unexposed	Humidity[1]
Haze[2]	44.2	44.5
Yellow Index[3]	1.0	1.1
Adhesion[4] [%]	100	100

ASTM D-2247 – 750h @52°C and 100% RH
ASTM D-1003
ASTM D-1925
ASTM D-3359

Anti-Microbial Properties

	Escherichia coli			*Staphylococcus areus*			Antimicrobial efficacy against blank) Reduction %
	Number of living bacteria		Antimicrobial activity value against blank	Number of living bacteria		Antimicrobial activity value against blank	
	At beginning	After 24 h		At beginning	After 24 h		
Coating AB1 (blank)	1.4×10^5	3.0×10^7		1.8×10^5	9.5×10^5		
Coating AB1 (0.2%)	1.4×10^5	$<1 \times 10^2$	>5.4	1.8×10^5	$<1 \times 10^2$	>3.9	**>99.9**
Coating AB2 (blank)	1.4×10^5	3.2×10^7		1.8×10^5	2.8×10^5		
Coating AB2 (0.2%)	1.4×10^5	$<1 \times 10^2$	>5.4	1.8×10^5	$<1 \times 10^2$	>3.4	**>99.9**
Coating AB3 (blank)	1.4×10^5	3.2×10^7		1.8×10^5	2.8×10^5		
Coating AB3 (0.2%)	1.4×10^5	$<1 \times 10^2$	>5.5	1.8×10^5	$<1 \times 10^2$	>3.4	**>99.9**
Control Uncoated ABS	1.4×10^5	3.7×10^7		1.8×10^5	3.7×10^7		

JIS 2801

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Spray Application

- Continuous Agitation of Formulation to Maintain Homogeneity
- Spray Booth Relative Humidity: < 50%
- Spray Booth Air Temperature: 23 - 27ºC
- Spray Gun: Conventional
- In-Line Filter: 10 -15 micron (1250 – 625 mesh)
- Flash off: 3-5 min @ 35 - 40ºC Convection Oven
- UV: 1000mJ/cm^2 (EIT UVA) Medium Pressure Mercury Lamp

Other Considerations

- Quality of Molded Keyboards
- Cleaning of Keyboards
- Proper Choice of Solvents
- Accurate Processing Parameters
- Adequate Thickness Measurements

Quality of Molded Keyboard Keys

Poor quality molding
Non uniform surface

Cleaning of Keyboards

- Insufficient cleaning results in smearing of contaminants
- Improper cleaning can lead to non-uniformity of gloss and adhesion problems.

Proper Choice of Solvents

- Typically spray application requires at least three types of solvents – fast, medium and slow evaporating
- IR vs Convection oven
- Limited solvent options in order to prevent chemical attack to ABS

Temperature and Humidity Test

Coating 1 processed within thickness, flash off and UV energy recommended ranges

Coating 1 coated with insufficient UV energy

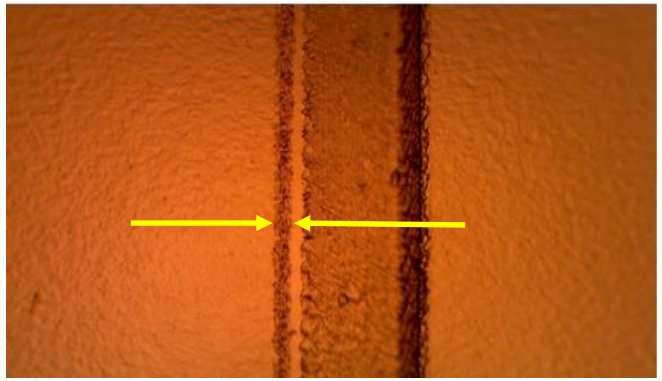
Coating Thickness Measurements

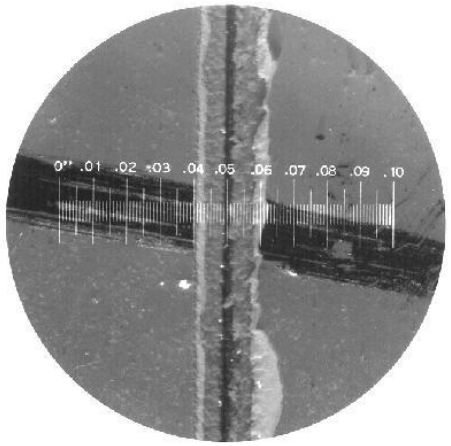
- **Micrometer**

  Difference in thickness of coated and uncoated substrate

- **Tooke Gage**

  Microscopic observation of a precision cut





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Conclusions

- New UV curable coatings
- Low gloss
- Abrasion and wear resistance
- Chemical resistance
- Durability under environmental conditions
- Thin dry film thickness
- Compliance with international health, safety and environmental standards

Thank you for your attention

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