



# High Performance Keyboard Coatings

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# Need of Protective Coatings



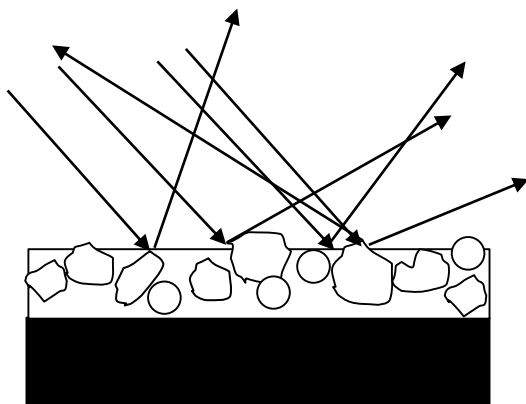


# Keyboard Coatings Challenges

- 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

400nm

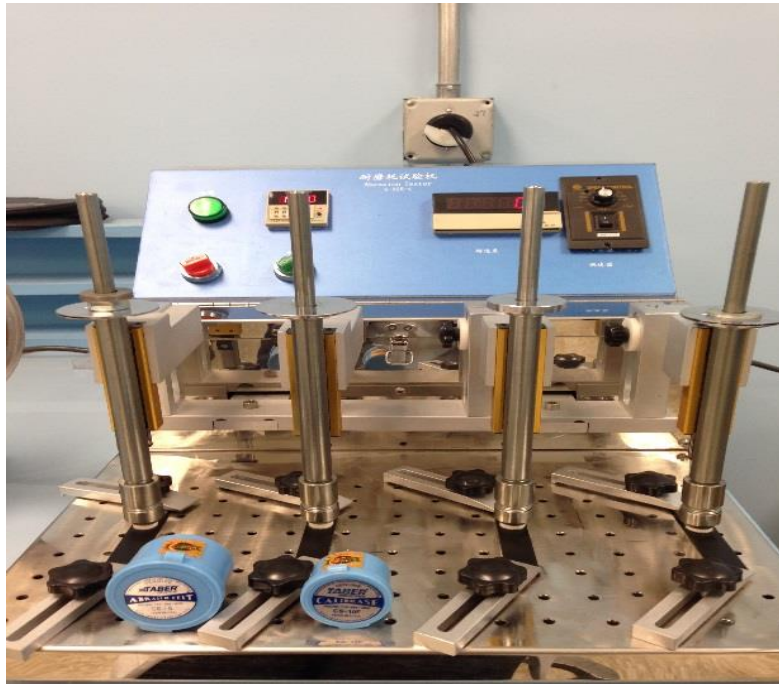
500nm

600nm

700nm

750nm

# 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



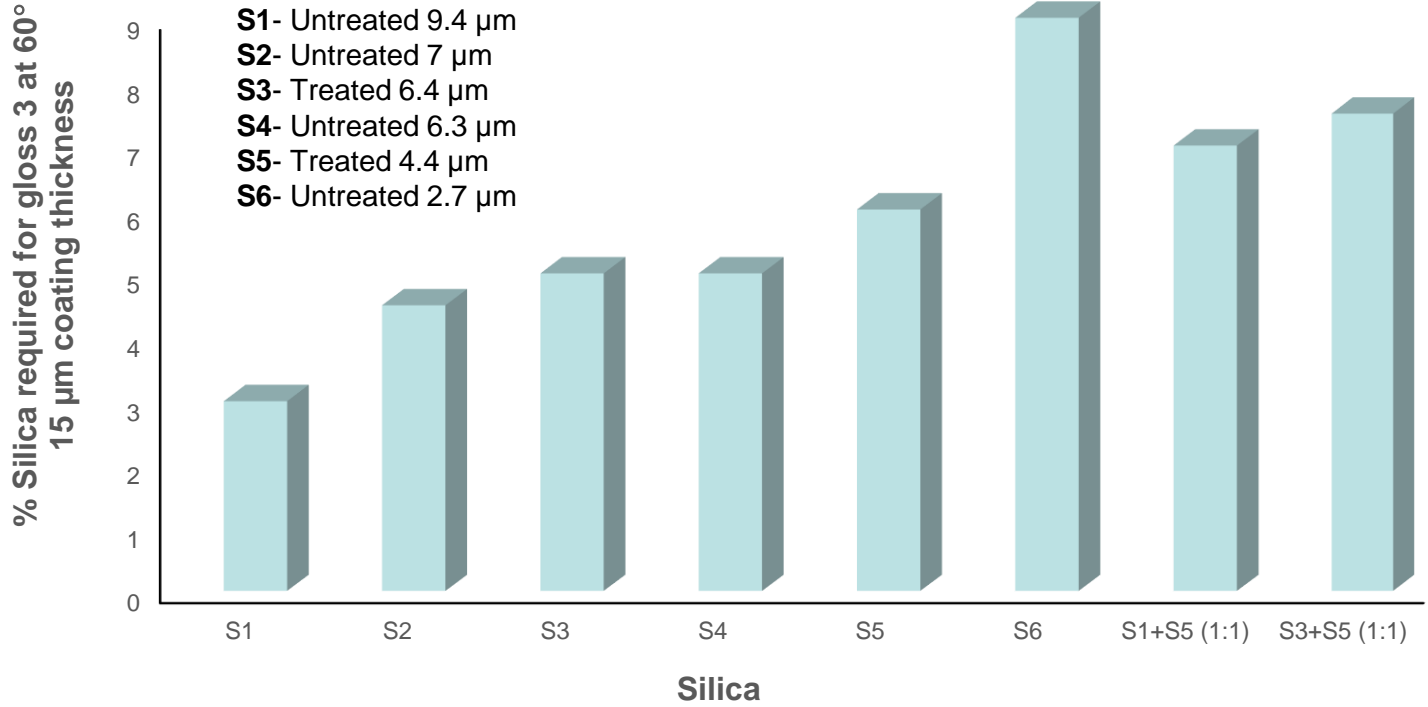
# Gloss Reduction

- 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

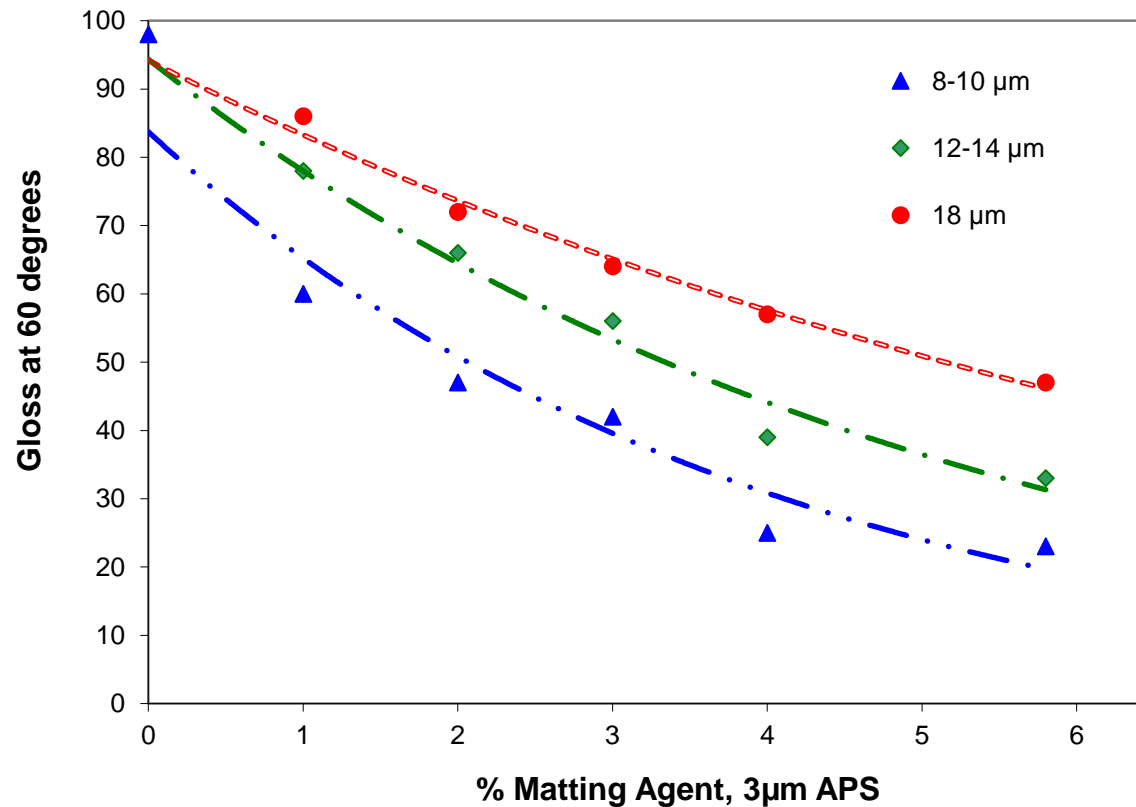


# Gloss Reduction with Silica



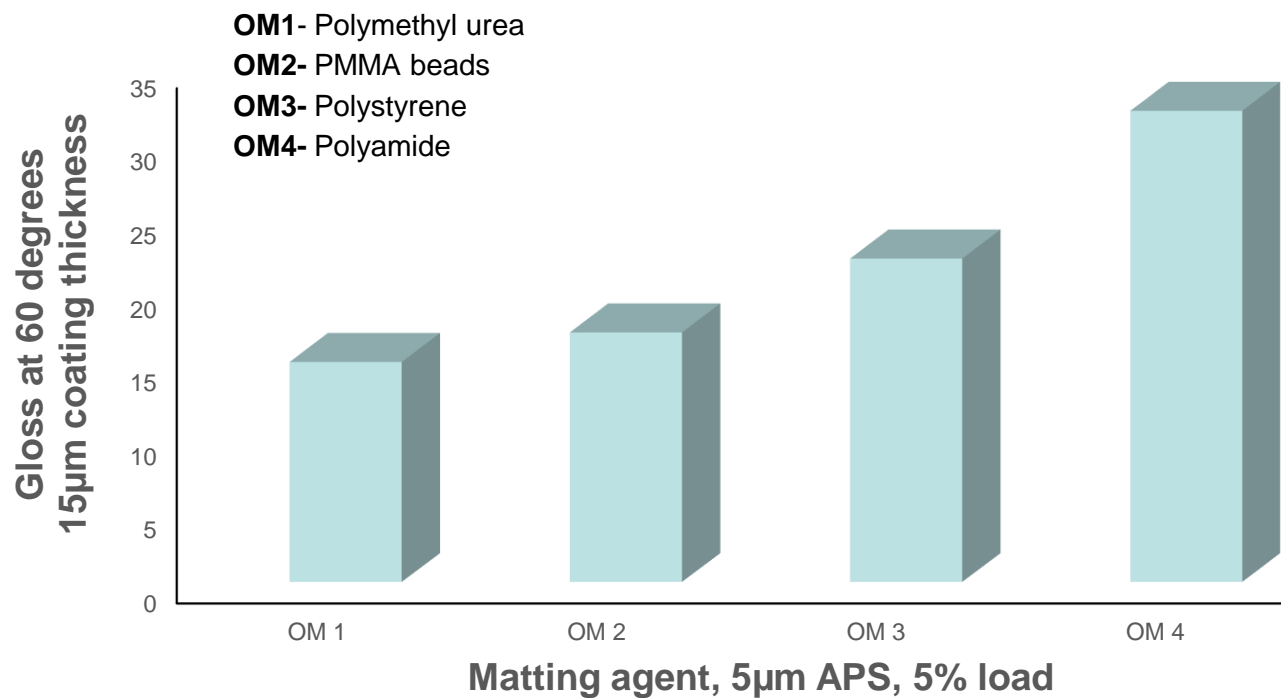


# Gloss Reduction - Coating Thickness Dependence





# Gloss Reduction with Organic Particles

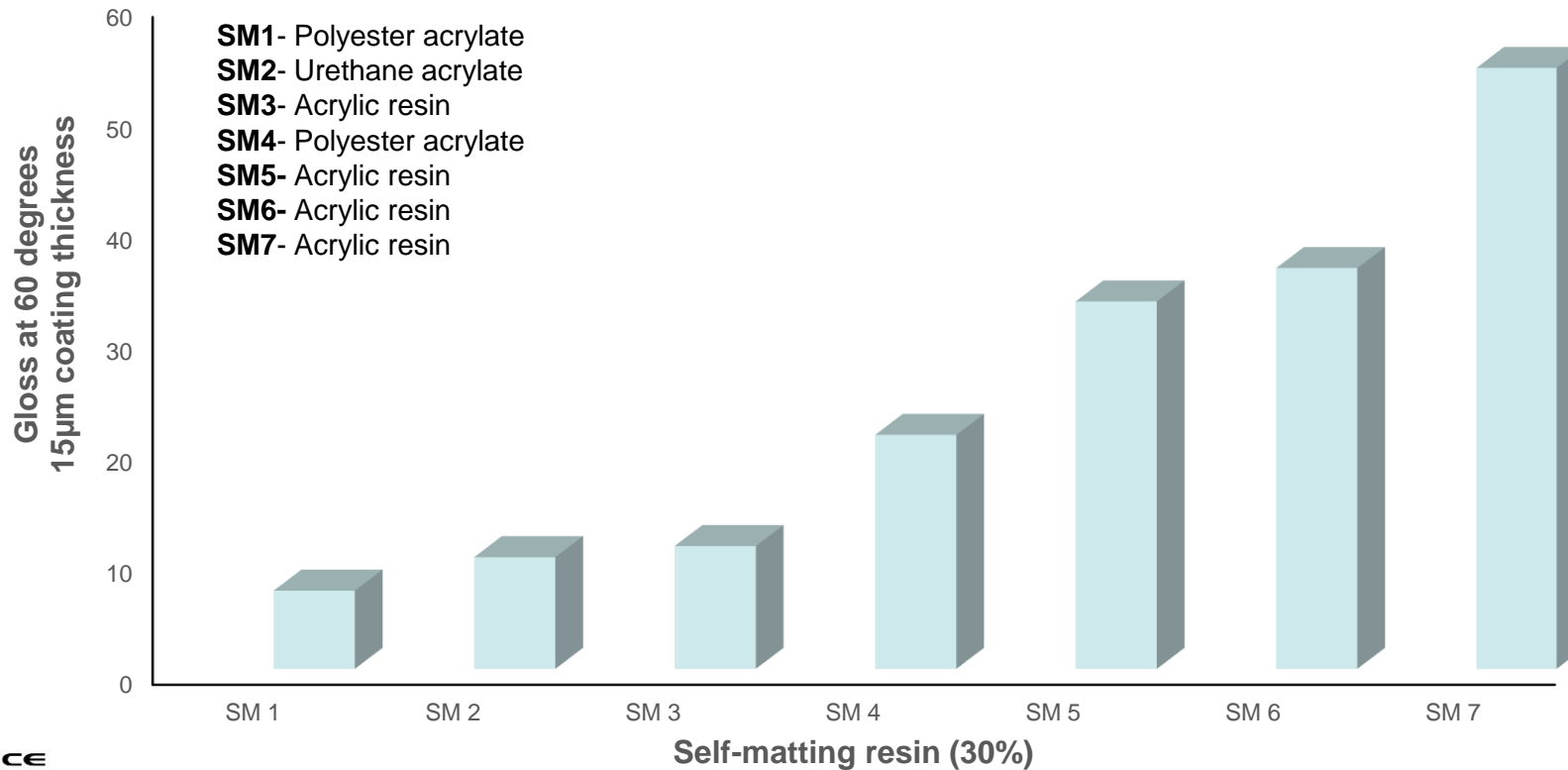




# Gloss Reduction

- 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



# Gloss Reduction Using Different Resins

Type of resin in solvent borne anti-glare formulation	60° Gloss at 8 μm coating thickness on polycarbonate	Taber <sup>a</sup> 100 cycles	Taber <sup>a</sup> 500 cycles	Pencil Hardness <sup>b</sup>
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

<sup>a</sup>ASTM D-1044, CS-10 wheels, 500g load @ 100 and 500 cycles %Δ – Haze – PC data

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

<sup>a</sup> ASTM D-3359

<sup>b</sup> ASTM D 523

<sup>c</sup> Measured with micrometer

<sup>d</sup> Described earlier

<sup>e</sup> ASTM F-2357

<sup>f</sup> ASTM D 3363 750g load, Mitsu-Bishi Hi Uni pencils, ABS

<sup>g</sup> Rotary test representing scratching using #0000 steel wool pad at load @5 rotations. (No scratches at load) – PC data

# 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

400nm

500nm

600nm

700nm

750nm

# 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





# Environmental Test Results

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

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

400nm

500nm

600nm

700nm

750nm

# Anti-Microbial Properties

	<i>Escherichia coli</i>		Antimicrobial activity value against blank	<i>Staphylococcus aureus</i>		Antimicrobial activity value against blank	Antimicrobial efficacy against blank) Reduction %
	Number of living bacteria			Number of living bacteria			
	At beginning	After 24 h		At beginning	After 24 h		
Coating AB1 (blank)	1.4 x 10 <sup>5</sup>	3.0x10 <sup>7</sup>		1.8x10 <sup>5</sup>	9.5x10 <sup>5</sup>		
Coating AB1 (0.2%)	1.4 x 10 <sup>5</sup>	<1x10 <sup>2</sup>	>5.4	1.8x10 <sup>5</sup>	<1x10 <sup>2</sup>	>3.9	>99.9
Coating AB2 (blank)	1.4 x 10 <sup>5</sup>	3.2x10 <sup>7</sup>		1.8x10 <sup>5</sup>	2.8x10 <sup>5</sup>		
Coating AB2 (0.2%)	1.4 x 10 <sup>5</sup>	<1x10 <sup>2</sup>	>5.4	1.8x10 <sup>5</sup>	<1x10 <sup>2</sup>	>3.4	>99.9
Coating AB3 (blank)	1.4 x 10 <sup>5</sup>	3.2x10 <sup>7</sup>		1.8x10 <sup>5</sup>	2.8x10 <sup>5</sup>		
Coating AB3 (0.2%)	1.4 x 10 <sup>5</sup>	<1x10 <sup>2</sup>	>5.5	1.8x10 <sup>5</sup>	<1x10 <sup>2</sup>	>3.4	>99.9
Control Uncoated ABS	1.4 x 10 <sup>5</sup>	3.7x10 <sup>7</sup>		1.8x10 <sup>5</sup>	3.7x10 <sup>7</sup>		

JIS 2801



# Spray Application

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





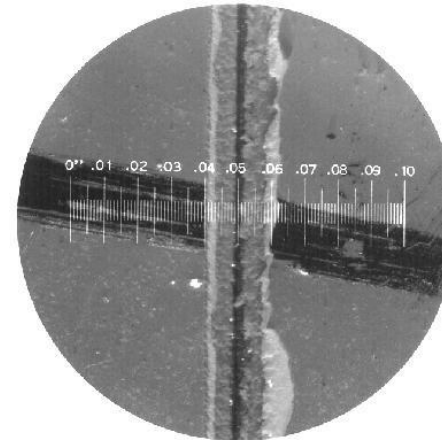
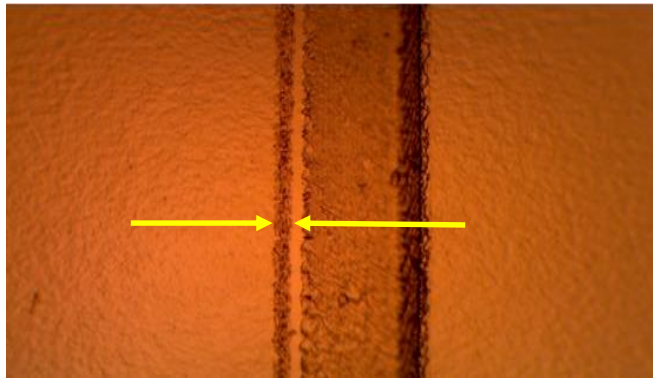
# Coating Thickness Measurements

- **Micrometer**

Difference in thickness of coated and uncoated substrate

- **Tooke Gage**

Microscopic observation of a precision cut





# 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*