CYTONIX

CytoPel

CytoPel Properties

- Two versions 400 and 500
- Liquid solution
- Fluorinated or organic solvents
- Customizable:

  improve adhesion to select substrates and modify mechanical properties through addition of these functional groups:

  - Epoxy
  - Silane
  - Other

- Applications:

  Microfluidic devices

  Printed circuit boards

  Pipette tips and tubes

  Earphones and headphones

  Conformal coatings

- Other properties:

Minimal masking

Low dielectric constant

High glass transition temperature

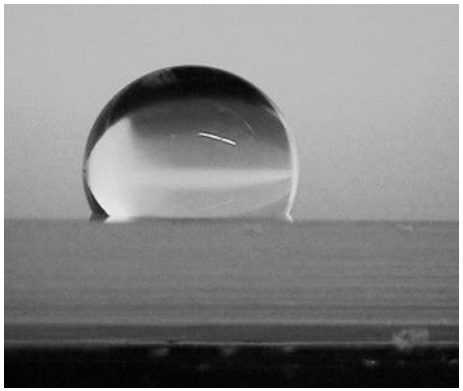
Low surface energy

Low water absorption

High solvent resistance

CytoPel Properties II

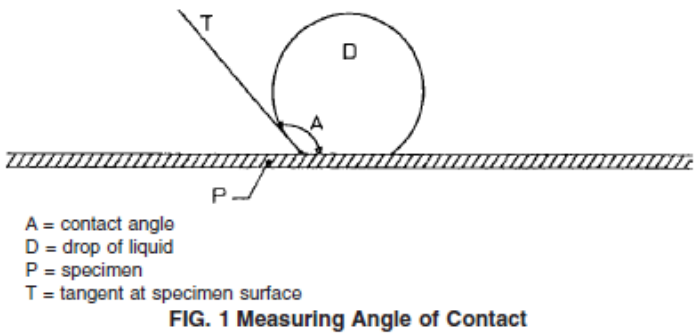
Property	CytoPel 500 Concentrate	CytoPel 400 Concentrate
Cost	6X	1X
Shipping	Any	Ground or Sea, Warning- **Flammable!**
Appearance	Clear, Odorless, Colorless film	Clear, Odorless, Colorless Film
Contact Angle (Water)	>110˚	>100˚
Contact Angle (Oil)	>60˚	>50˚
Hardness	>H pencil	>H pencil
Film Flammability	Non-Burning	Non-Burning
Solvent Flammability	Non-Burning	Flammable
Tracer	UV tracer for quality control (at request)	UV tracer for quality control (at request)
Heat Stability Continuous	150ºC	150ºC
Max heat stability (1 hour)	250ºC	250ºC



Property	CytoPel 500 Concentrate	CytoPel 400 Concentrate
Refractive Index Surface	~1.34	~1.34
Toxicity	HMIS Rating Health = 1	HMIS Rating Health = 1
Ease of Application	Very Good	Very Good
Solvent/Chemical Resistance	Good	Excellent after curing
Transparent	Yes	Yes
Electrical Conductivity	Yes (at <0.5 µm film thickness)	Yes (at <0.5 µm film thickness)
Ease of Dry	Room Temperature in <5 minutes	Room Temperature in <5 minutes
Low Labor	May not require masking	May not require masking
Removable	Easily Removable	Yes
Solder-Through Repairable	Yes	Yes

Data Analysis: Contact Angle

Standard Practice for Surface Wettability of Coatings, Substrates and Pigments by Advancing Contact Angle Measurement: <u>ASTM standard D7334-08</u>



Schematic extracted from ASTM standard

Image before analysis (left) and after (right).

Description of Method:

A coated substrate is placed onto a balanced stage where a 5 µL droplet is deposited onto the substrate via a hypodermic needle. The drop is released 3mm above the substrate and the image is taken within 30 seconds. At least two samples are analyzed per coating in at least 6 different locations on the substrate. Images are analyzed, data is averaged, and the data is documented.

Contact Angle: CytoPel 500 and Water

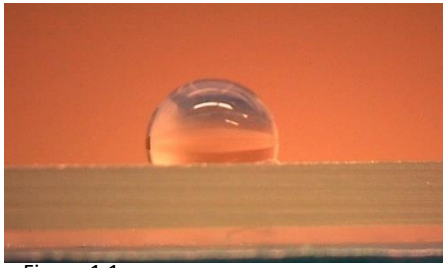


Figure 1.1

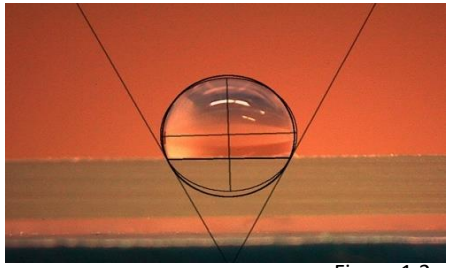
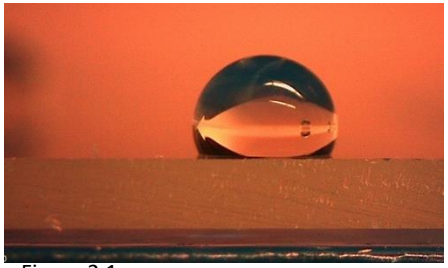


Figure 1.2

0.5% Concentration
Average Contact Angle:
112.1˚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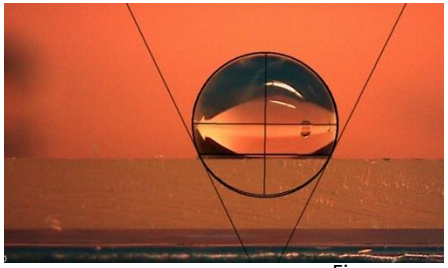


Figure

1.0% Concentration
Average Contact Angle:
113.3˚


Figure 3.1

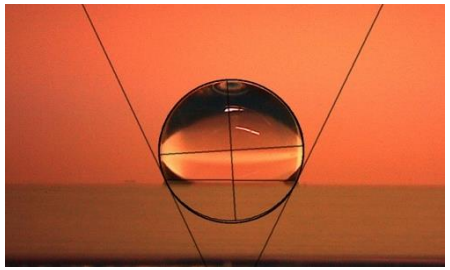


Figure 3.2

2.0% Concentration
Average Contact Angle:
113.3˚

CytoPel 500 exhibits contact angles >110˚ for water.

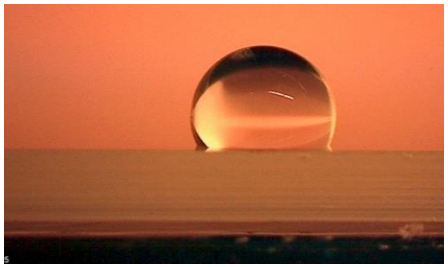


Figure 4.1

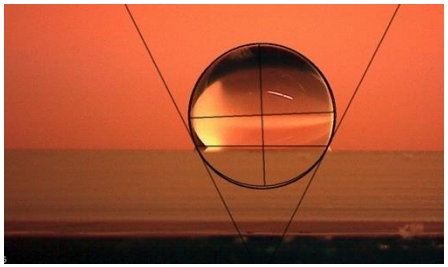


Figure 4.2

4.0% Concentration
Average Contact Angle: 113.1˚

Contact Angle: CytoPel and Oil

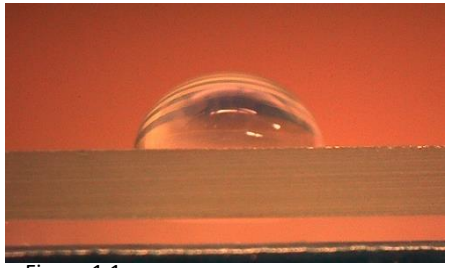


Figure 1.1

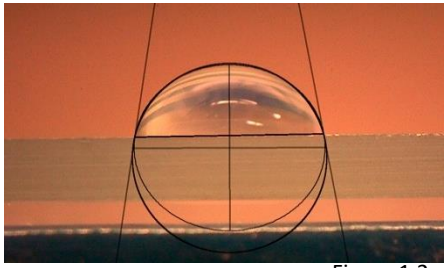


Figure 1.2

0.5% Concentration
Average Contact Angle:
78.9˚

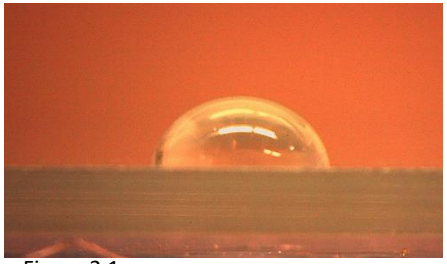
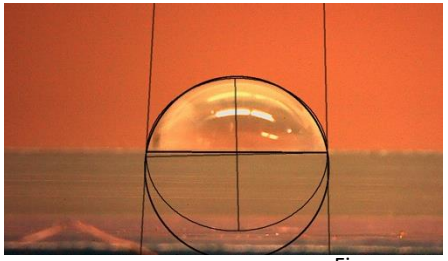


Figure 2.1



Figure

1.0% Concentration
Average Contact Angle:
80.5˚

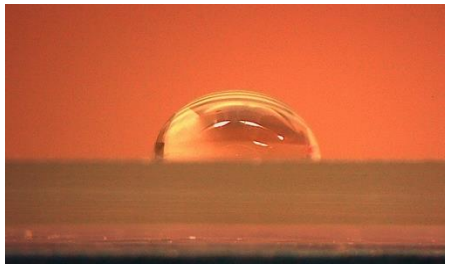


Figure 3.1

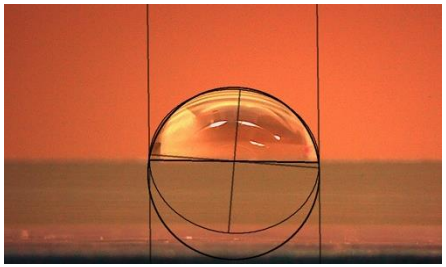


Figure 3.2

2.0% Concentration
Average Contact Angle:
82.0˚

Figure 4.1

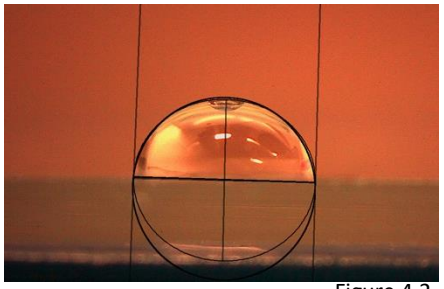


Figure 4.2

4.0% Concentration
Average Contact Angle: 82.8˚

CytoPel 500 exhibits contact angles >80° for oil.

Contact Angle: CytoPel 400

Water | Oil

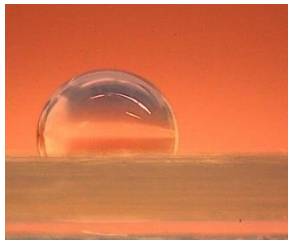


Figure 1.1


Figure 1.2

1.0%


Figure 1.3


Figure 1.4

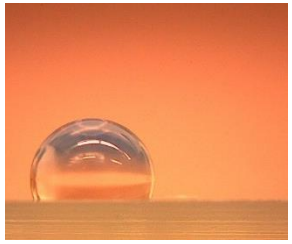


Figure 2.1


Figure 2.2

2.0%

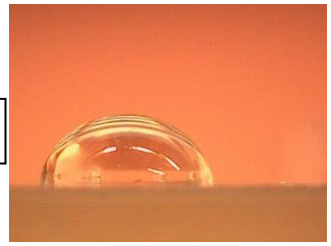


Figure 2.3

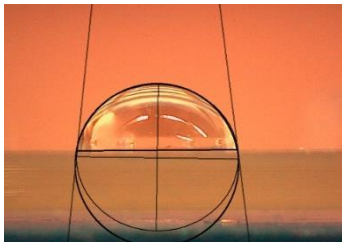


Figure 2.4

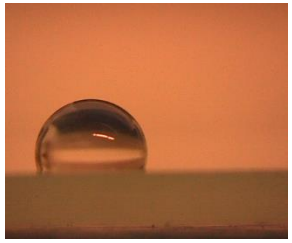


Figure 3.1

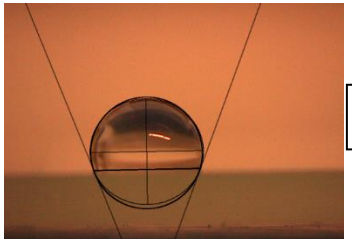


Figure 3.2

4.0%


Figure 3.3

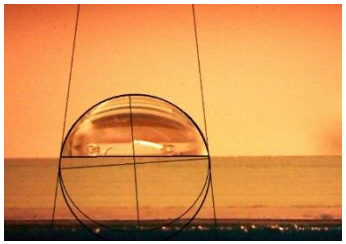


Figure 3.4

	Water	Oil
1.0%	104.8	77.1
2.0%	109.6	79.8
4.0%	108.1	79.9

**Diluted with Ethyl Acetate*

CytoPel 400 exhibits contact angles of >100º for water and contact angles of >75º for oil.

ASTM Standard D3363-05

Standard Test Method for Film Hardness by Pencil Test

Description of Method:

A coated substrate is placed onto a firm horizontal surface. A pencil with a blunt, flat lead is pushed away at a 45° angle for a distance of 6.5mm.

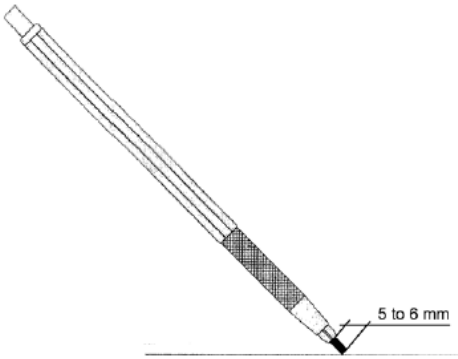


FIG. 2 View of Mechanical Holder with Sharpened Drawing Lead

Schematic extracted from ASTM standard

Based on Visual Observation:

- Pencil Hardness: Pencil Mark Present: Indicated with "**M**"
- Scratch Hardness: Scratch Mark Present: Indicated with "**H**"

Sample Concentration	#	4H	3H	2H	H	F	HB	B	2B	3B	4B	Pencil Mark	Pencil Hardness
0.05%	1	H	H	H	H	M	M	M	M	M	M	F	H
0.05%	2	H	H	H	H	M	M	M	M	M	M	F	H
1%	1	H	H	H	H	M	M	M	M	M	M	F	H
1%	2	H	H	H	H	M	M	M	M	M	M	F	H
2%	1	H	H	H	H	M	M	M	M	M	M	F	H
2%	2	H	H	H	H	M	M	M	M	M	M	F	H
4%	1	H	H	H	H	M	M	M	M	M	M	F	H
4%	2	H	H	H	H	M	M	M	M	M	M	F	H

CytoPel 500

Sample Concentration	#	4H	3H	2H	H	F	HB	B	2B	3B	4B	Pencil Mark	Pencil Hardness
1%	1	H	H	H	H	M	M	M	M	M	M	F	H
1%	2	H	H	H	H	M	M	M	M	M	M	F	H
2%	1	H	H	H	H	M	M	M	M	M	M	F	H
2%	2	H	H	H	H	M	M	M	M	M	M	F	H
4%	1	H	H	H	H	M	M	M	M	M	M	F	H
4%	2	H	H	H	H	M	M	M	M	M	M	F	H

CytoPel 400

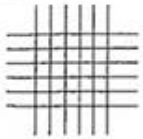
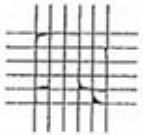
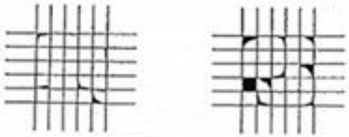
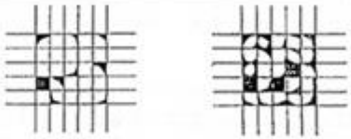
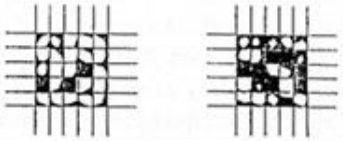
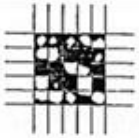
Pencil Hardness Scale extracted from ASTM standard:

$$\underset{\text{Softer}}{6B-5B-4B-3B-2B-B-HB-F-H-2H-3H-4H-5H-6H}\ \text{Harder}$$

The 500-Series and 400-Series coatings have pencil hardness ratings of "H."

Data Analysis: ASTM Standard 3359-09

Standard Test Methods for Measuring Adhesion by Tape Test

Classification	% of Area Removed	Surface of Cross-cut Area From Which Flaking has Occured for 6 Parrallel Cuts & Adhesion range by %
5B	0% None	
4B	Less than 5%	
3B	5 - 15%	
2B	15 - 35%	
1B	35 - 65%	
0B	Greater than 65%	

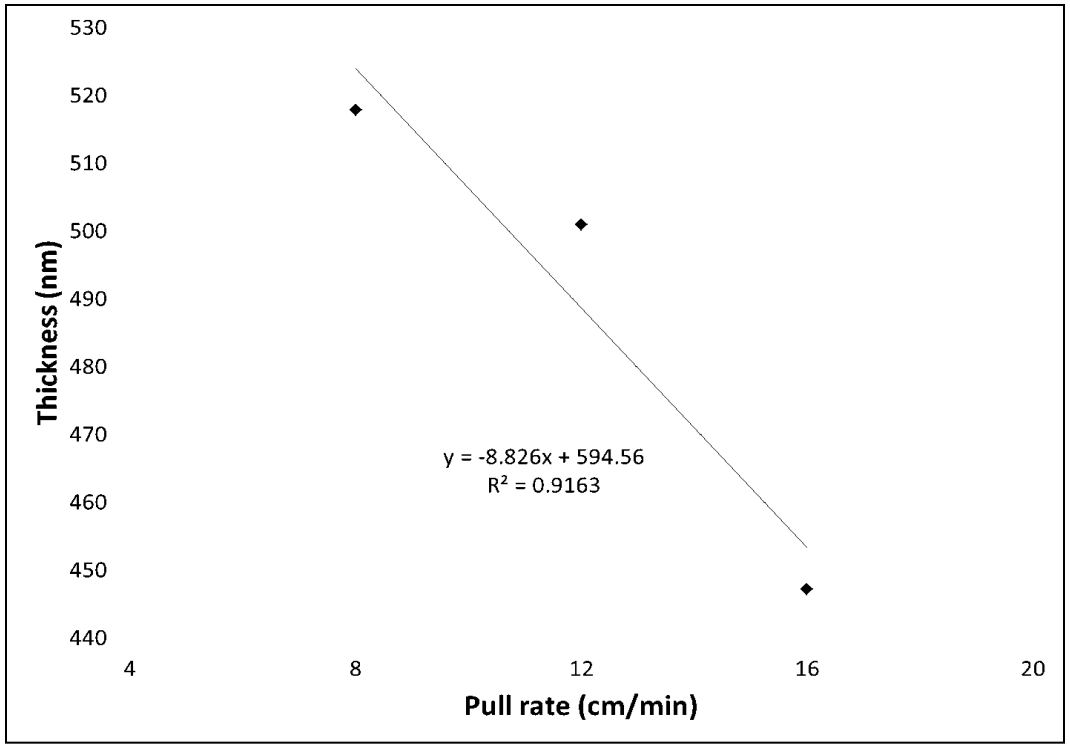
Description of Method:

A coated substrate is secured onto a firm, horizontal surface. A razor is used to create the grid pattern. Packing tape is smoothed over the pattern and removed at a 180° angle. At least two samples are evaluated for each coating.

Coating:		500 0.50%	500 1.00%	500 2.00%	500 4.00%	400 1.00%	400 2.00%	400 4.00%
Test	Substrate	Rating	Rating	Rating	Rating	Rating	Rating	Rating
S1S1	Glass	5B	5B	5B	5B	5B	5B	5B
S1S2	Glass	5B	5B	5B	5B	5B	5B	5B
S2S1	Glass	5B	5B	5B	5B	5B	5B	5B
S2S2	Glass	5B	5B	5B	5B	5B	5B	5B
S1S1	Aluminum	5B	5B	5B	5B	5B	5B	5B
S1S2	Aluminum	5B	5B	5B	5B	5B	5B	5B
S1S1	Copper	5B	5B	5B	5B	5B	5B	5B
S1S2	Copper	5B	5B	5B	5B	5B	5B	5B
S1S1	PC	5B	5B	5B	5B	5B	5B	5B
S1S2	PC	5B	5B	5B	5B	5B	5B	5B
S1S1	ABS	5B	5B	5B	5B	5B	5B	5B
S1S2	ABS	5B	5B	5B	5B	5B	5B	5B

Both versions at all concentrations exhibit 5B, the highest adhesion rating.

Withdrawal Rate vs. Coating Thickness

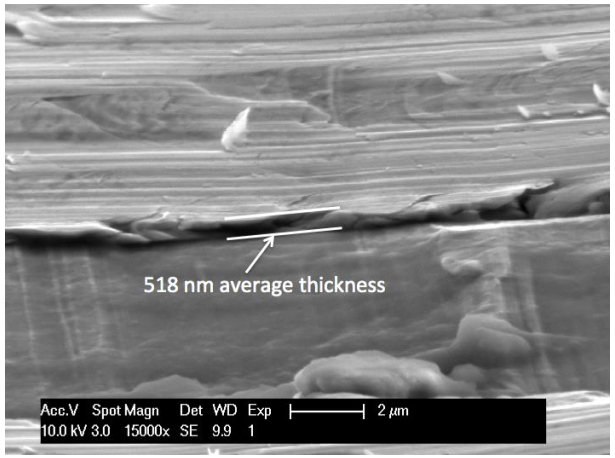


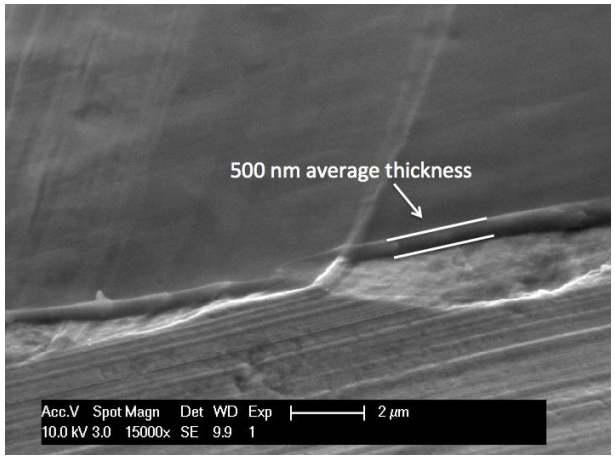
Thickness (nm)	Withdrawal Rate (cm/min)
518	8
500	12
447	16

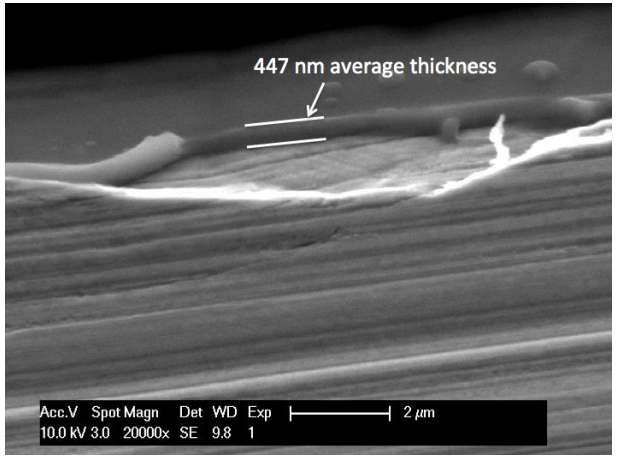
A linear relationship is demonstrated in the model:

Y= -8.826x + 594.56

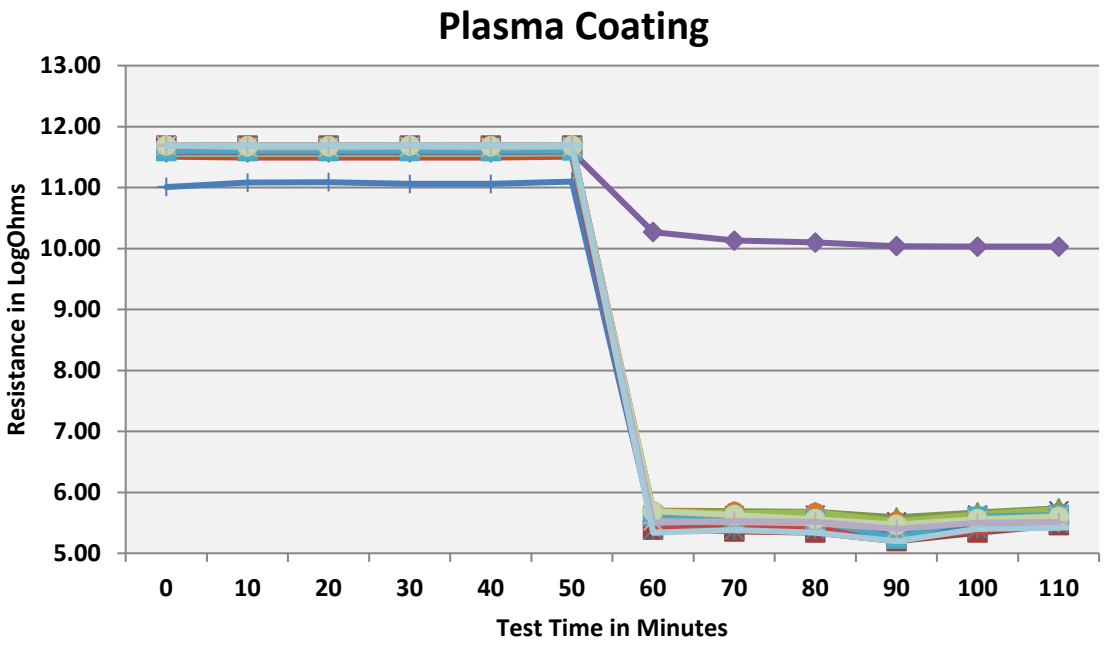
Increasing withdrawal rate decreases coating thickness







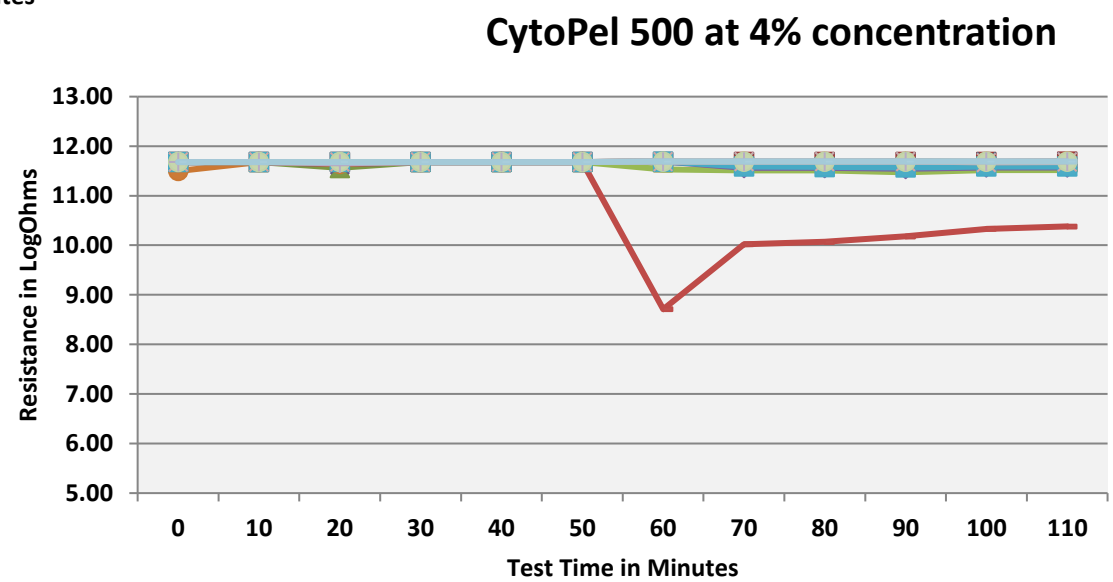
CytoPel 500 vs. Plasma Coating



Water Immersion Test

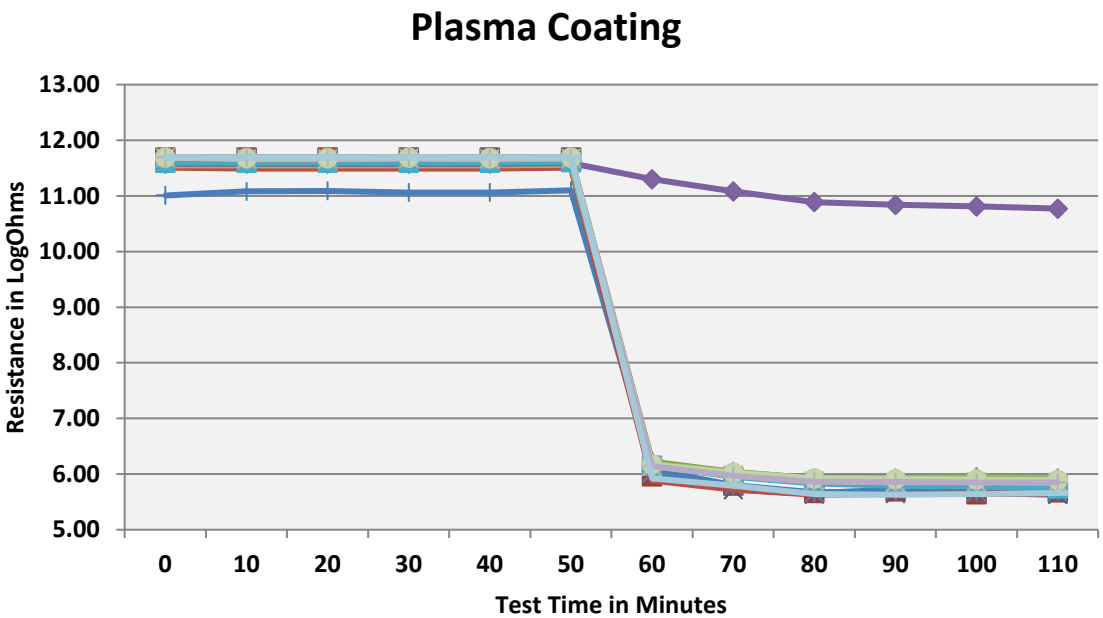
- At 50 minutes the boards were submerged in water
- Each line of data represents a different component on the board

The CytoPel 500 survives the water immersion test, whereas the plasma coating fails.



**These results were obtained from one of our customer's R&D trials involving a third party testing facility.*

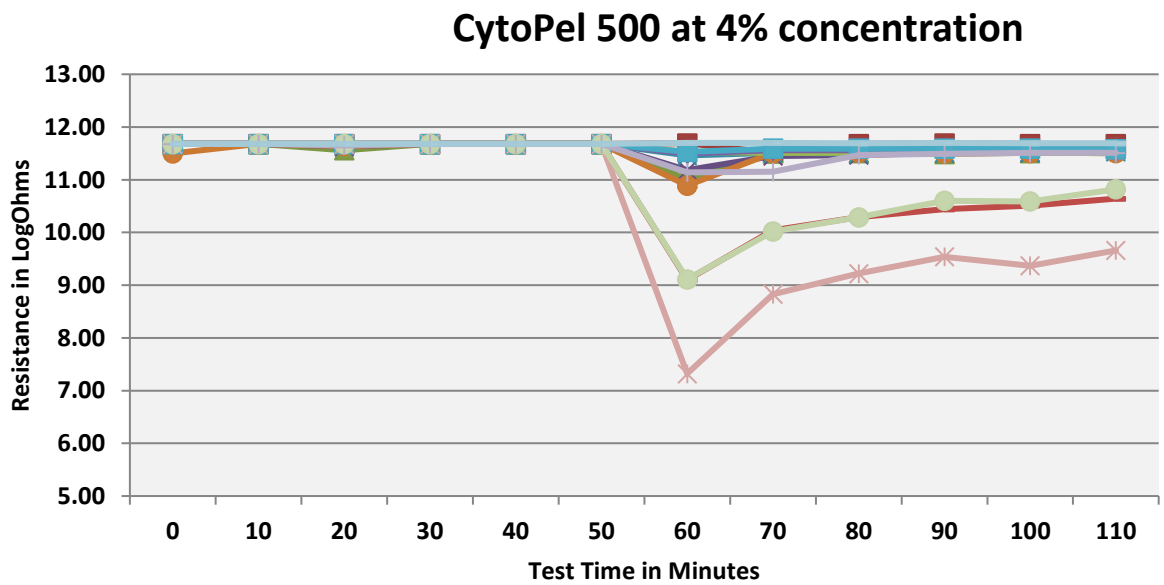
CytoPel 500 vs. Plasma Coating



Coca-Cola Immersion Test

At 50 minutes the boards were submerged in Coca-Cola

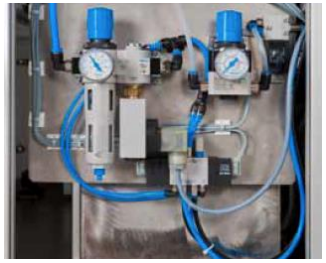
Each line of data represents a different component on the board

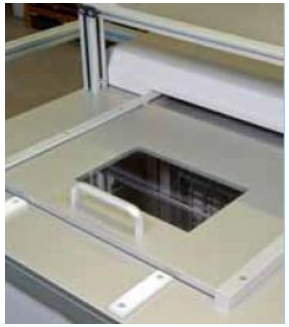


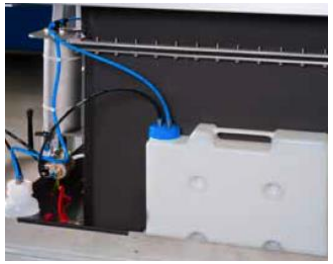
The CytoPel 500 survives the Coca-Cola immersion test, whereas the plasma coating fails.

**These results were obtained from one of our customer's R&D trials involving a third party testing facility.*

Implementation into Manufacturing







Coating systems are available that are specifically designed for fluoropolymer coating solutions.

It is possible that a conformal coating machine that your company has already acquired will also work with our liquid solution by making minor control adjustments.

These coating systems will offer a low cost, automated turnkey solution.

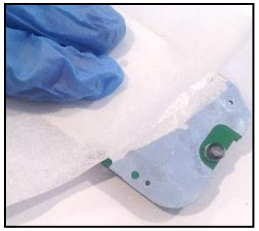
A few facts about some available systems:

•Controls Percent Solids
•Full automation available
•Filtration system available
•Specifically designed for highly volatile solvent systems
•Cooling trap to collect condensed liquid and cycle it back into the system
•Water is separated and removed
•Low Waste
•Efficient
•Cost Effective

Coating Process in Manufacturing

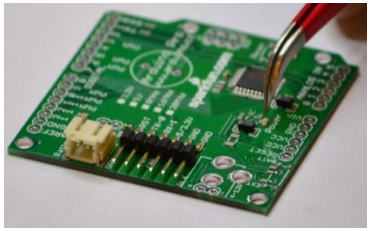
Step 1: Preparation & Cleaning

- IPA, compressed air, or both


Step 2: Masking if Necessary

- Optical lenses
- Microphones
- Speaker assemblies possible

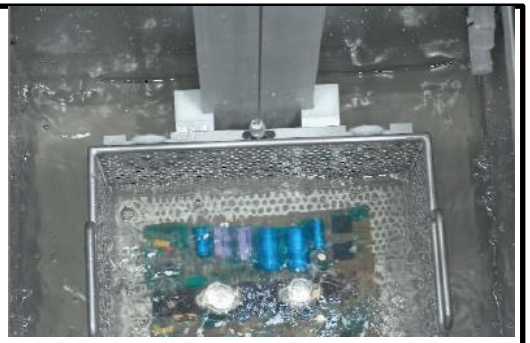



Step 3: Load PCB's

-coating tray recommended 90° for optimal coating

Step 4: Immersion

- Immerse components in bath for a total of 30-45 seconds (test speed starting with 15cm/min)



Step 5: Cure

- CytoPel 500: Heat cure optional
- CytoPel 400: Heat cure at 60ºC for 10 minutes

Step 8: Quality Control

UV tracer additive can be added for quality control purposes

Conclusions

Transparency	Visually Undetectable
Thickness	400 – 500 nanometers
Reworkable	Easily Reworkable
Thermal Dissipation	Does not trap heat allowing for the coating to withstand high temperatures
Easy Application	Dip, Spray, Syringe
No large Start-Up Costs	Large, expensive, noisy equipment is not necessary - liquid solution
Easy to Implement	Can be used in common conformal coating equipment by adjusting the control settings
Customizable	Concentrations, additives, solvent systems - we work R&D teams to find a solution that works