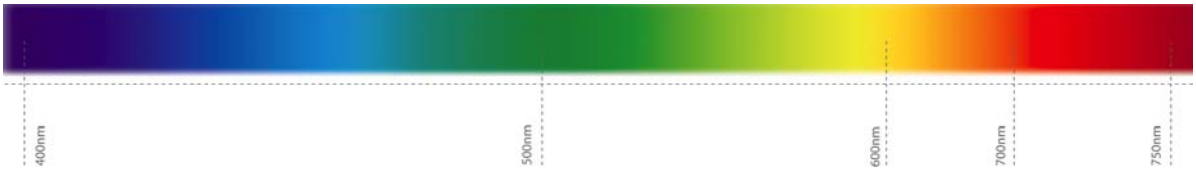


TopPro® 701 Hi-Performance Topcoats

Screen Applied, UV Curable Coatings For Plastics, Paper & Metals

Independent Testing by SPTF

Screen Printing
Technical Foundation
10015 Main Street, Fairfax, Virginia 22031 USA
Telephone: (703) 385-1417
Fax: (703) 273-0456
Telex: 904059 WSH

PCI's new TopPro® 701 Clear UV-curable, screen applied coating was tested by the independent Screen Printing Technical Foundation (SPTF) and earned distinction.

"We followed your pre-established procedures for material preparation and printing as closely as possible. For your convenience, the data summary is divided into the following categories:

1. Testing Methodology

   This is a detailed account of the testing methodology used at SPTF to prepare and evaluate the product. It includes the chemical, graffiti and abrasion resistance testing, as well as any incidentals noted or needed to complete the assignment.

2. Data Summary – Graphic Format

   All data has been condensed into a statistical summary of the results presented in a multicolor plotted graphic formal (labeled Graph A-H). Graphs A-E are plots of cured coating thickness on various substrate materials. Please note each data point plotted on these graphs is an average of ten ink thicknesses at ten different points on the substrate. The vertical lines running through each data point represent the average plus and minus three sigma (a statistical estimate of the range of the thickness variations per sample). All thicknesses are in micrometers or "microns" (25.4 microns equal 1/1000 of an inch). The average and standard deviation listed at the bottom right of each graph is the overall average of all the samples represented by that graph. (Note: When using the standard deviation to compare data, small is better, signifying less variation.)

   Graphs D and E are of a standard black UV ink printed under the same set of conditions for a direct comparison. For example, if you compare Graph A to Graph D we can see the "matte clear" product is laying down and shrinking about the same deposit thickness as a typical black UV ink; however, the clear product is producing a more uniform deposit thickness. (Compare a Std. Dev. of 1.47 micron for matte clear to 2.04 microns Std. Dev. for the black UV product.)

   It is also interesting to note that the cured deposit thicknesses do change slightly when different substrate materials are used. The uniformity of the laydown can also be affected greatly by the substrate material. (See Graphs A, B and C.)

   In addition to the deposit thickness and uniformity of thickness, we also measured surface roughness using a surface profilometer. In this case, "Rz" was chosen to represent the relative roughness of the cured materials and the substrates on which they were deposited. Again, as in the case of Std. Dev., a smaller Rz value is better and indicates a smoother surface. Our Rz numbers (Graphs F, G and H) are in micrometers. In summary, what the Rz test demonstrates is that your product prints as smoothly or even smoother than similar UV curable screen printable inks.

3. **General Observations**

We found the matte clear product to be comparable to other UV screen printable inks in its ease of use and preparation and superior in the areas of solvent resistance, abrasion/scratch resistance and resistance to "graffiti". It is an extremely tough, flexible coating (as claimed) with no visually apparent optical problems".

R. D. Hunt, SPTF Research Manager.

Note: "The **Rz** value is a numerical reference to the mesh/coating equalization on the screen. Mesh equalization is the process of filling the mesh openings with coating and building up a thick coating layer to equalize (or smooth out) the surface structure of the woven mesh. In other words, mesh equalization means achieving a smooth coating on the uneven surface of the mesh. Mesh equalization is essential for sharp, saw-tooth free printing."

Wolfgang Pfirrmann, Kissel & Wolf GmbH, Wiesloch, Germany.

SPTF Testing Procedures Used for PCI's
Matte Clear UV Curable Cover Coat
(New Product Development)

1.0 Stretched Precision 406/34 on Newman Roller Frame 18"x20"

Initial Tension	10 N/cm	wait 15 min.
Retension to	14 N/cm	wait 15 min.
Retension to	18 N/cm	wait 15 min.
Retension to	20 N/cm	wait 15 min.
Retension to	22 N/cm	wait 15 min.
Retension to	25 N/cm	wait 15 min.
Retension to	25 N/cm	wait 30 min.
Retension to	25 N/cm	wait 1 hour
Retension to	25 N/cm	Screen ready

(Measured tension with Tetko 40D Electronic Tensiometer)

1.1 Abrade screen with – Ulano Microgrit 2.

1.2 Degreased screen with – Autotype Universal Mesh Prep.

2.0 Applied capillary Autotype CPLX 18 (received on site 6/17/93).

2.1 A 3"x3" square was exposed using the Olec Exposure Unit (30 units).

2.2 Blocked out with – Ulano No. 60 Screen Filler 6.

3.0 A "System Automation" pneumatic press was used for printing (squeegee durometer 80).

4.0 Substrates (vinyl and polyester) were prepared by wiping with Windex using a lint free cloth.

5.0 Mixed Matte Clear:

5.1 Air temperature 77 degrees F, 49% RH.

5.2 Matte clear temperature 76.5 degrees F.

6.0 Cured all samples on Svecia S-51-M Jetair/UV Dryer.

6.1 Performed cross hatch to adjust for cure.

6.2 (Vinyl) 70 FPM, 105 degrees F.

6.3 (Polyester) 70 FPM, 106 degrees F.

6.4 Cleaned screen with ICC 841.
Air-dried.

7.0 Printed Nor-Cote Opaque Black UV ink on polycarbonate samples.

7.1 Cured 45 FPM, 105 degrees F.

7.2 Also printed UV ink overlapping Matte clear on vinyl substrates.

7.3 Cured 45 FPM, 105 degrees F.

7.4 Samples 1-10 wiped with dust cloth before printing noted fish eyes occurring, wiped samples 11-96 with alcohol, fish eyes still occurring.

7.5 Cleaned screen with ICC 841.
Air-dried.

8.0 Printed Matte clear over polycarbonate samples.

8.1 Samples 1-9 wiped with dry cloth.
Samples 10-18 wiped with alcohol.
No apparent difference.

8.2 Cured 55 FPM, 106 degrees F.

9.0 Chemical Resistance Testing

9.1 Procedure

- Sprayed samples with ICC 841 and wiped noticed distortion of substrate and UV ink. **No visual damage to coated surface**.
- Wiped with Acetone, notice distortion in substrate, **no visual damage in coated surface.**

10.0 Graffiti Proof Testing

10.1 Procedure

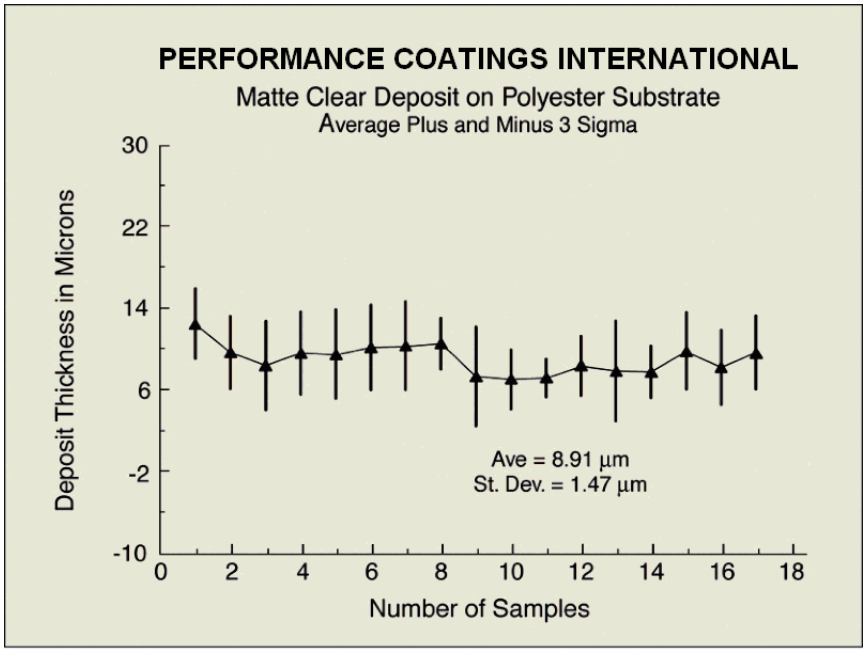
- Applied ball point pen, wiped off easily with alcohol.
- Applied permanent marker, set overnight removed easily with alcohol from coated surface, would not come off UV ink surface.
- Applied liquid paper, let set overnight, wiped off fairly easily with alcohol from all surfaces, but left slight impression on coated surfaces.
- Applied nail polish, let set overnight, sprayed surface with alcohol, polish scratched up relatively easily from coated surface, would not come off from un-coated surfaces.

11.0 Abrasion Resistance Testing

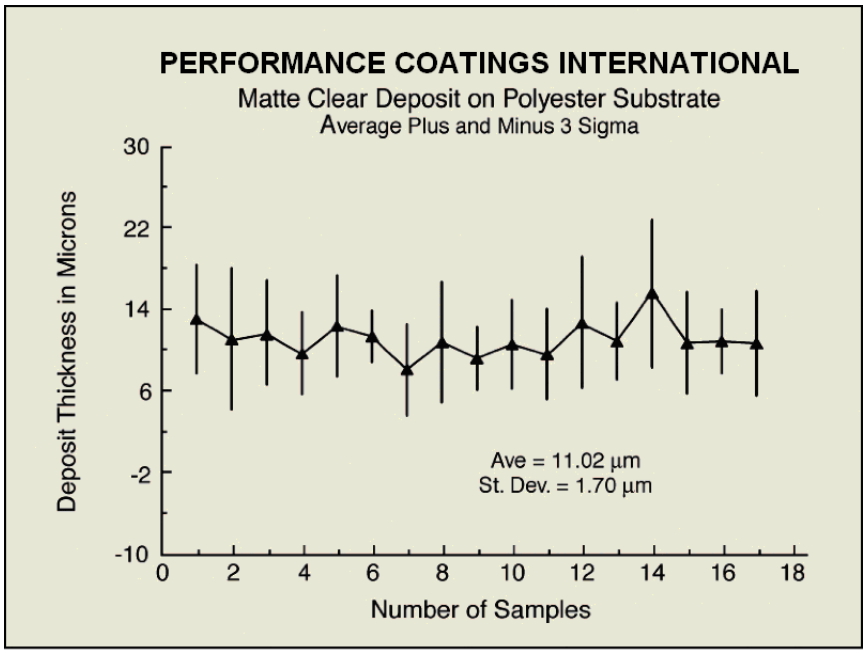
11.1 Procedure

Rubbed steel wool over surface, scratched uncoated surfaces.
No visual effect to coated surfaces.

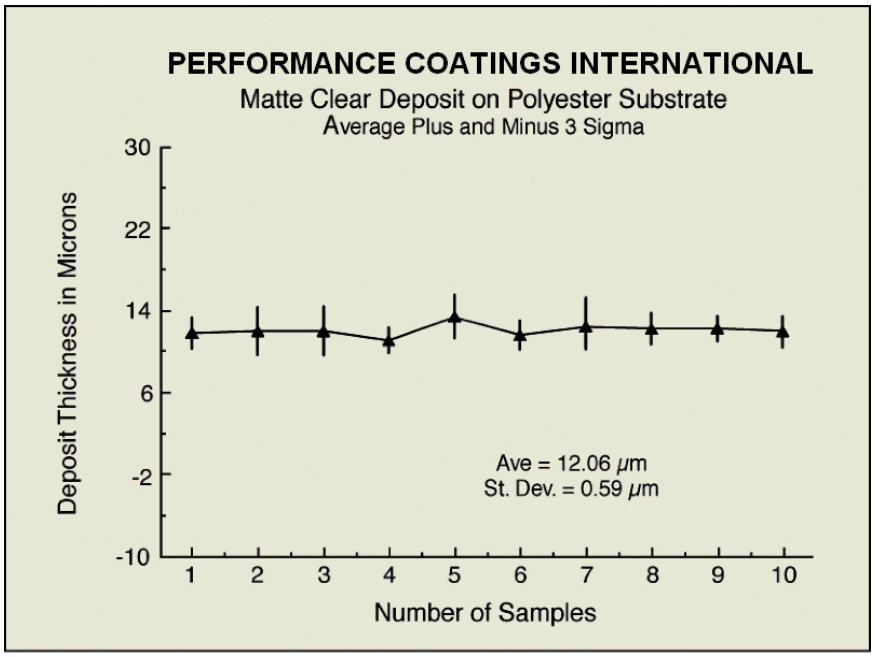
GRAPHICAL TEST RESULTS



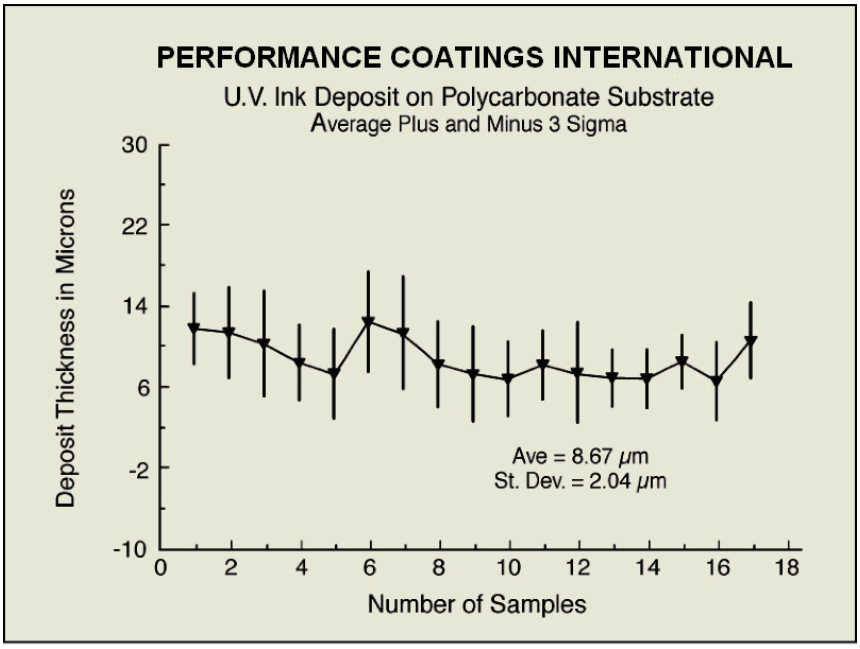
Graph A



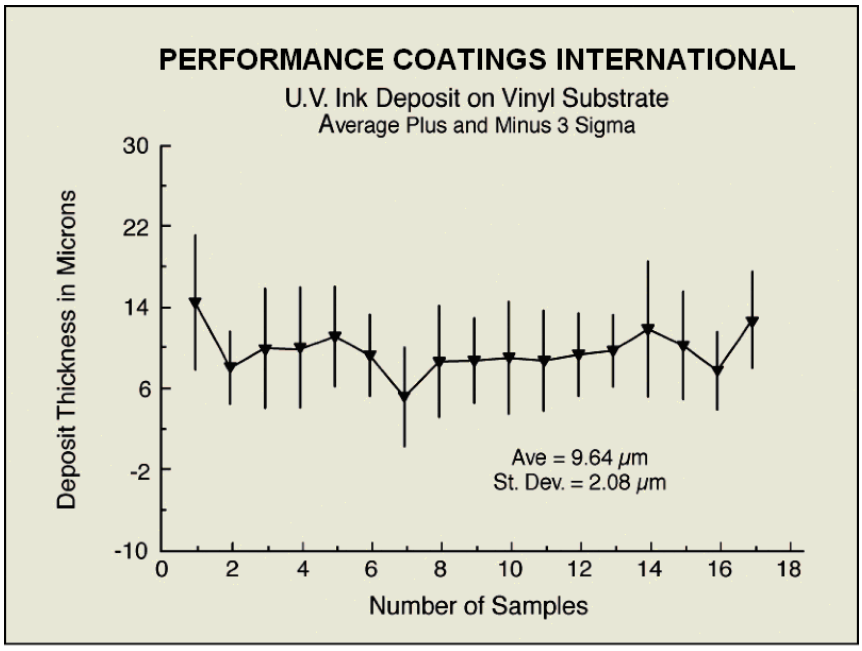
Graph B



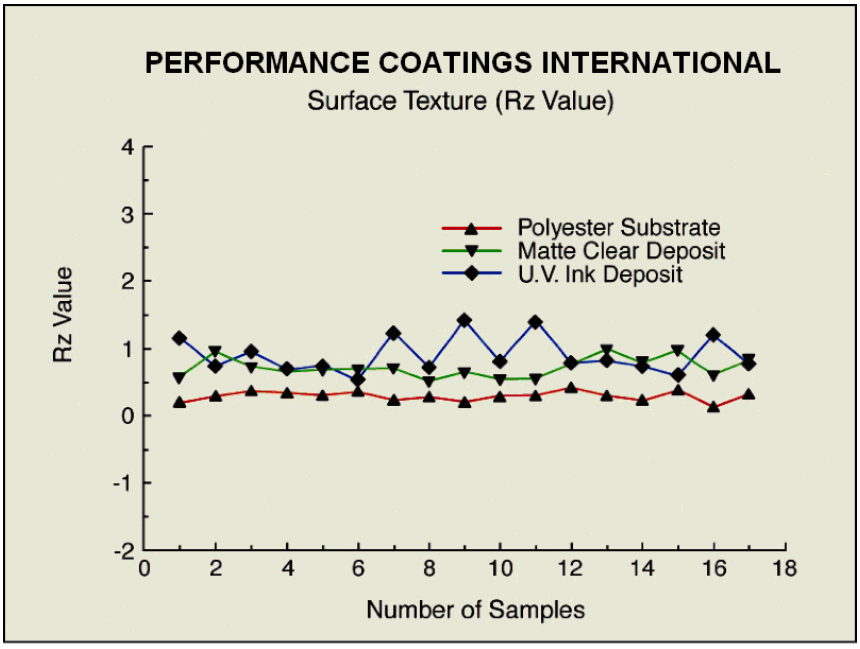
Graph C



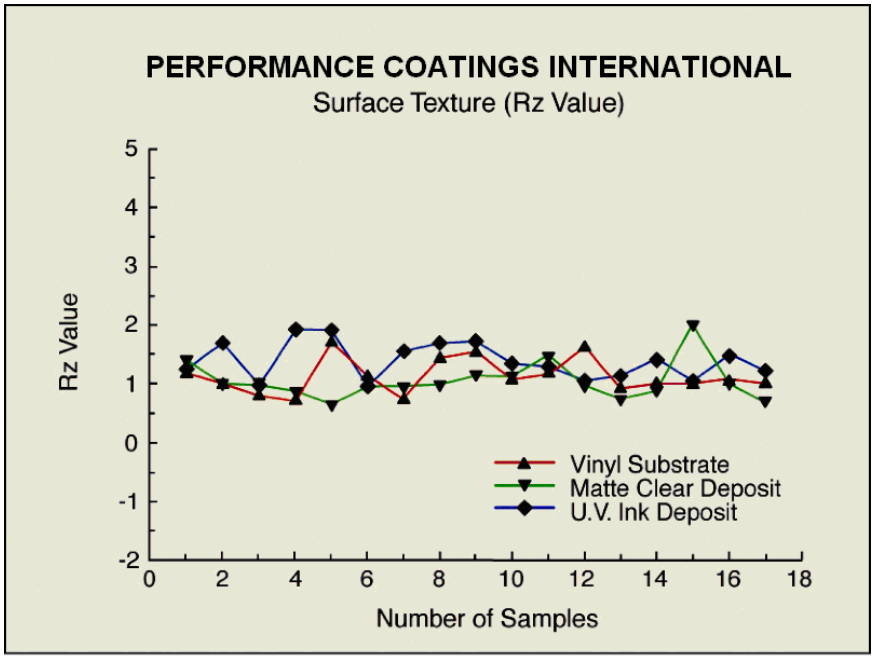
Graph D



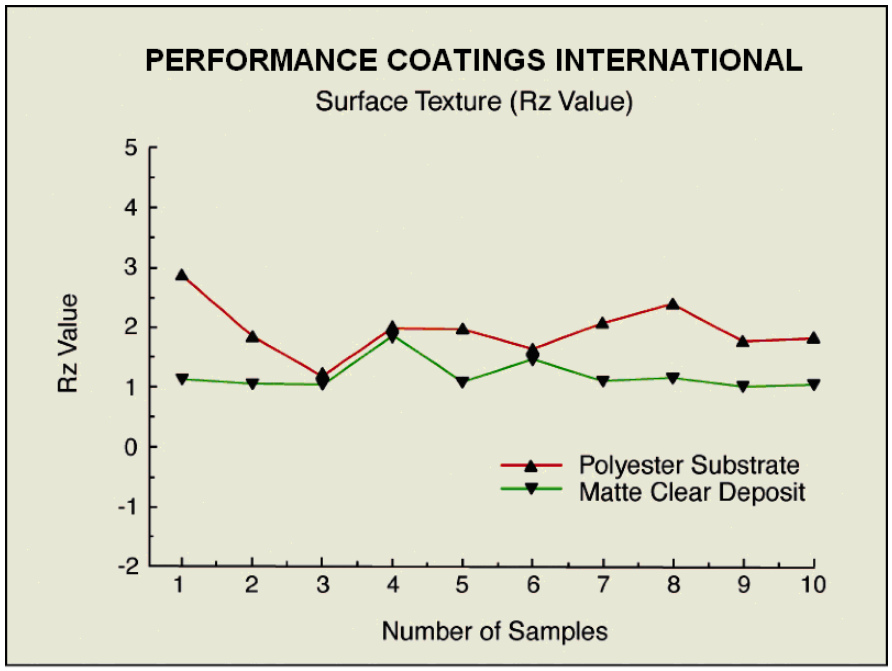
Graph E



Graph F



Graph G


PERFORMANCE COATINGS INTERNATIONAL
Surface Texture (Rz Value)
Rz Value
5
4
3
2
1
0
-1
-2
1
2
3
4
5
6
7
8
9
10
Number of Samples
Polyester Substrate
Matte Clear Deposit

Graph H