UltraViolet Absorption of Latex Paints:

By Kirk Huizenga
kirkh@unique-software.com
2003

Purpose:
For many years there has been discussions on the Pietenpol mail list as to the suitability of exterior latex paint as a "system" for covering an aircraft. A number of builders have completed their projects and have used latex paint to cover the fabric with claimed success.

One issue that had not been tested is the ability of latex paint to protect Dacron fabric from damaging UV light. In standard systems, there is a "barrier" layer of paint applied prior to color coats. In the Poly-fiber system this is called Poly-spray. In the past, builders that have used latex paint to cover their fabric have sealed the fabric with black latex paint with the idea that black paint would absorb the most visible light and, hopefully, UV light. This, in turn, would protect the fabric from degradation.

I have considered using latex paint on my Pietenpol rebuild, but wanted to be certain that it would, in-fact protect the fabric from UV degradation. There are builder that have had latex covered fabric for over 10 years without incident, but better safe than sorry. One should not assume that because visible light is being blocked that UV light is also being blocked.

Methodology:
I contacted a friend of mine, Dr. Tom Varberg, a Professor of Chemistry at Macalester College in St Paul, MN and asked him about testing the paints. Tom agreed to help me in the testing by using a Beckman DU7400 Spectrometer. The spectrometer can record Transmittance, the amount of visible and ultraviolet light lost (or conversely, absorbed) by a material. Transmittance is the ratio of radiant power (P_O) that makes it through the substance (paint) to the radiant power (P) sent into the substance.

$$T = \frac{P_O}{P}$$

Transmittance can then be converted to Absorption (A) with the formula.

$$A = -\log T$$

Tom also supplied me with a small disk of quartz to use as a base for testing the paint at an appropriate thickness - similar to that expected when covering fabric. Quartz does not absorb or restrict UV light in the wavelengths we were testing (400-200nm) and therefore would not introduce error in the absorption readings.

I applied 4 different paints (1. Kilz Latex White 2. Glidden Exterior Latex-Wooland Green 3. Behr Exterior Flat – Black 4. Poly-Fiber Poly-Brush) to the quartz with a small brush.

After shooting a "blank" to calibrate the spectrometer, one of the painted areas on the disk was placed between the light source and the sensor. The light source flashes on (2 seconds for our test) and the sensor picks-up any energy that makes it through the paint.

The DU7400 gives a graphic representation of Absorbance at each wavelength (in nanometers). In the charts below, I averaged the Absorption of every block of 10 nanometer since there were 600 data points for each sample (from 800 to 200 nanometers).

As a curiosity, I also prepared some lightweight Poly-Fiber® fabric generously given to me by Gil Leiter of St Paul, MN and tested it. I heat shrunk the fabric and tested it with and without paint and Poly-Brush® (generously given by Pietenpoler, Robert Haines). The results are shown in Chart #2.

Limitations:

- The Beckman DU7400 Spectrometer is limited to an absorption of 4.5 (but we will consider that to be sufficient at T=.0031%)
- The DU7400 is likely to show erroneous data or noise when at either extreme of its measurement (0 or 4.5). Some data for specific wavelengths may not be accurate, but a trend is obvious
- The testing we did does not account for reflection. Any light reflected by the paint would show up as being absorbed. This doesn't really change the applicability of the test results, but does raise a question of what color paint is the best to use on sealing and protecting the fabric
- This is only a test of the UV blocking ability of latex paints. It does not deal with any other issues of using non-certified methods of covering and painting one's experimental aircraft like longevity, ability to seal the weave, adhesion, or flexibility/brittleness of latex paint.
- The Poly-Spray was tested with two layers – one on the front of the disk and one on the back. We found that this introduced some errors. Some of the energy that makes it through the first layer of paint gets bounced around between the two layers and gives odd readings.

Conclusions

- Latex paint can sufficiently blocks UV radiation and therefore protect Dacron fabric.
- Color does not seem to matter as far as level of absorption – differences are extremely minor (in the range of thousands of a percent)
- This is a matter open for discussion, but the practice of using black paint as the base/sealing coat on fabric to block UV light may not be the best practice. White, in theory, would be a better paint for that. White paint has a high amount of Titanium Dioxide (TiO2), which is highly reflective. Black paint, on the other hand, gets its "color" from Carbon Black primarily. Black paints have much less reflectivity and more absorption of light. Now, as I mentioned above, color does not seem to matter much in terms of protecting the fabric, but paint that is more reflective should last longer than paint that is more absorbing of light. It is not an issue of black or white being better at protecting the fabric, but rather the longevity and protection of the paint itself from breakdown.
- Brand of paint shouldn't make much difference in terms of UV protection, but could make a difference in durability and longevity of your paint job. There is information on the web about paint quality and there are some links below.

Equations:

$$A = \square \log T$$

$$T = 10^{\square A} \quad (T = 10\text{^}\square A \text{ in Excel})$$

$$\%T = 100(10^{\square A})$$

Resources and Links

Matronics Pietenpol List (with searchable archives)
http://www.matronics.com/pietenpol-list/index.htm

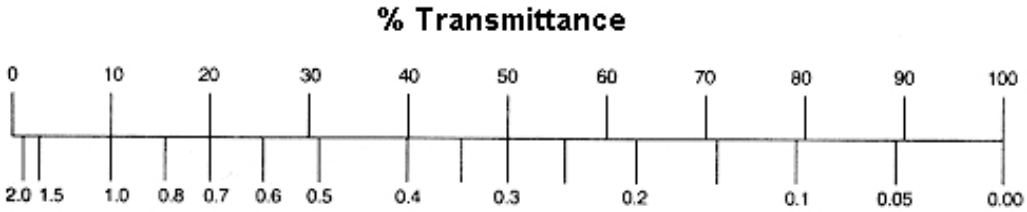
Data (Excel Spreadsheet)
http://mykitplane.com/Planes/filesList2.cfm?AlbumID=5

Dr. Tom Varberg, Professor of Chemistry, Macalester College
http://www.macalester.edu/chemistry/
varberg@macalester.edu

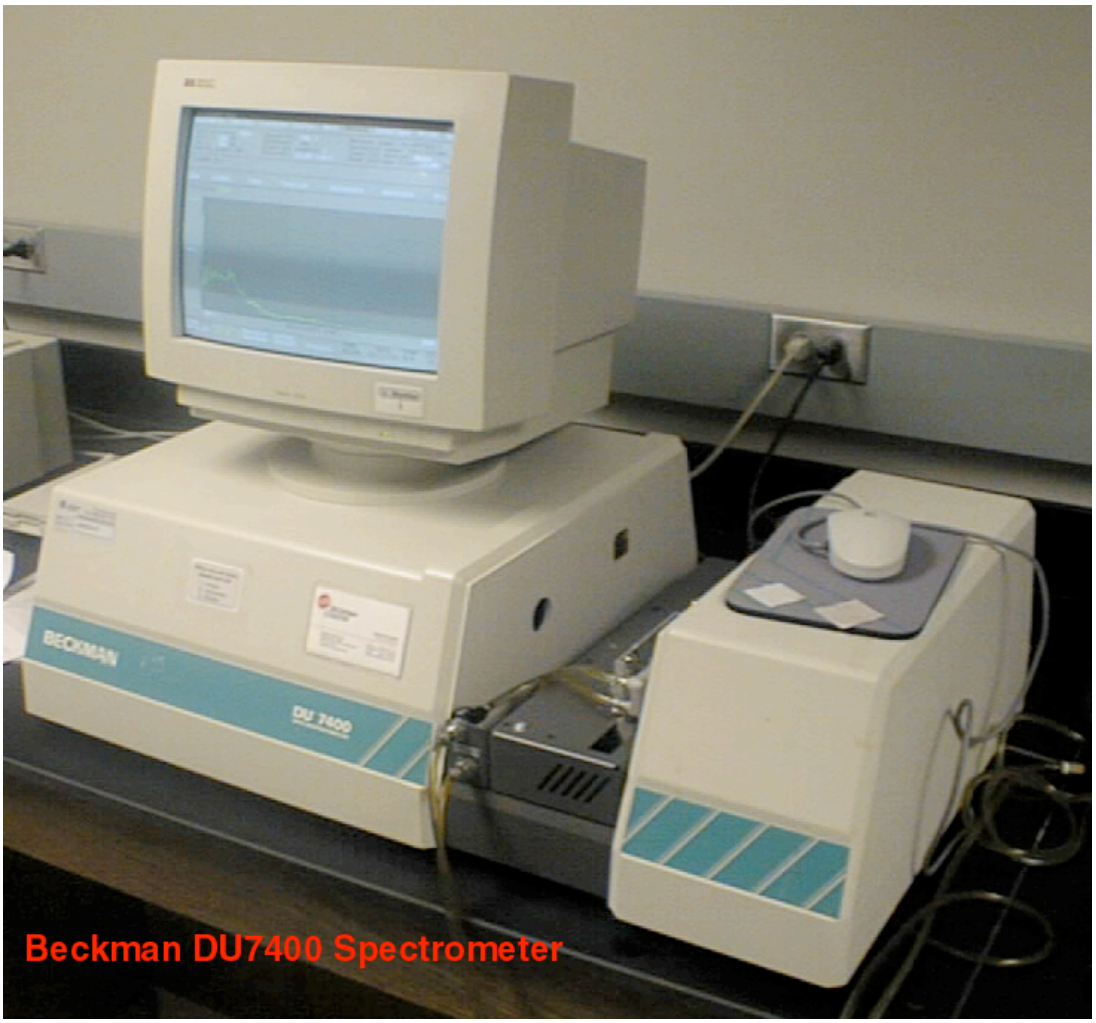
Covering Systems Information
http://polyfiber.com/
http://www.aircraftfinishing.com/

Absorption/Transmittance Info (Beer's Law)
http://www.shu.ac.uk/schools/sci/chem/tutorials/molspec/beers1.htm

Paint Information
http://www.paintstore.com/archives/misc/14.html
http://www.millenniumchem.com/Products+and+Services/ (TiO2 info)
http://www.paintquality.com/index_quality.html



from http://www.shu.ac.uk/schools/sci/chem/tutorials/molspec/beers1.htm



Beckman DU7400 Spectrometer

Chart #1

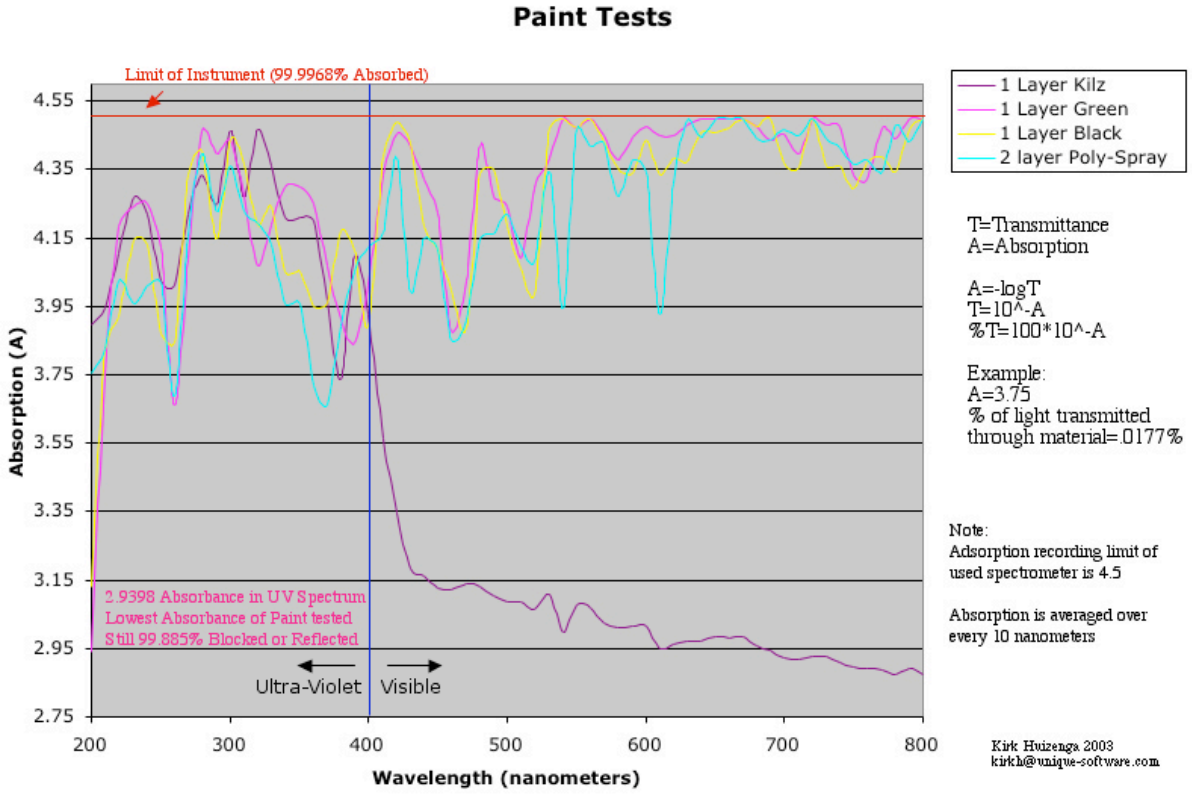


Chart #2