TECHNICAL PAPER

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High-Performance Labels for the Solar Photovoltaic Installation Industry

TYCO ELECTRONICS CORPORATION | APRIL 19, 2010

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Every day, solar photovoltaic installers struggle with correctly marking their installations in a way that is practical to implement and that meets the expectations of inspectors. Engraved plates and phenolic plaques are very durable, but require screws or rivets to affix them. The simplest solution to mark installations is to use adhesive labels, but standard labels often fade or peel away after being exposed to years of sunshine and weather.

However, high-performance labels achieve the goal of correctly marking the installation while providing a long-term solution that easily adheres to the components of the system.

The reasons why the labels are effective can be analyzed in the following steps:

1. The construction of the labels
2. The materials used
3. The test procedures to confirm performance

Label Construction

Labels are primarily constructed of the following components (See Figure 1)

- A top coat (consists of ink, varnish and/or overlaminate)
- The base film
- The adhesive
- The release liner

Description of Samples

Sample	Identification	Description	Test Substrate
1	SOL 1	Premium Vinyl, Special Ink & Laminate	Powder coated painted stainless steel
2	SOL 2	Cast Vinyl, Special Ink & Laminate	Textured powder coated painted aluminum
3	FLEX 2	Calendered Vinyl, Special Ink & Laminate	Textured powder coated painted aluminum

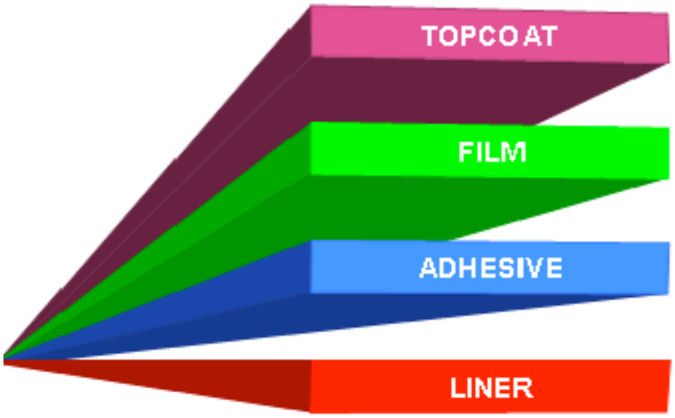

Figure 1. Construction of the high-performance labels for solar applications

Label Materials

The lamination material is a clear film formulated with UV inhibitors intended to filter out the destructive rays of UV radiation. This lamination not only provides added protection against ink fade, but also provides protection against moisture and salt spray.

The ink systems used on all labels under test are comprised of specially engineered pigments that have a relatively high resistance to prolonged UV exposure. The ink pigment used in the solar labels is also used in the automotive industry and has a long-standing history of outdoor exposure. Many of the colored inks being considered for solar labels are currently used in Department of Transportation applications.

The base material used is a high-performance, 2 mil (0.002 in) vinyl film with a high tack permanent acrylic adhesive. The material is formulated with premium raw material and processed to produce a vinyl film that resists the rigors of outdoor elements. The base film has been proven successful when used in other outdoor applications in other industries.

The permanent acrylic adhesive incorporated in the "SOL" material is appropriate for such outdoor applications as it has a proven track record of adhering to materials such as metal, glass and plastic substrates while exposed to extreme weather conditions. Test conditions including UV exposure, simulated rain, salt spray, thermal shock and fluid have revealed excellent resistance to fading, delamination, bubbling, cracking, hazing and chalking.

The base material used in the "Flex" sample is a basic calendered white vinyl with a permanent acrylic adhesive. The plasticizers and pigments used in the formulation of this vinyl are very common. The permanent acrylic adhesive incorporated in the Flex material is a typical pressure sensitive adhesive with moderately aggressive adhesion properties.

The release liner, although not a functional property of the label, is an important component in the label construction for its "lay flat" properties for sheet stock labels and for its non-blocking properties when in roll form.

Performance Testing

The labels were tested in three ways: exposure to UV light with water spray, prohesion (salt spray) and thermal shock.

TEST 1: UV Exposure

The test material, SOL 1, SOL 2 and Flex 2 were evaluated in accordance with ASTM D3424 Method 4. The test incorporated three main weathering forces: light, heat and moisture. The procedure was to expose the material to only 102 minutes of light at 63ºC Black Panel Temperature at 0.55 W/m² at 340 nm using Daylight Q filters, followed by 18 minutes of light and water spray – the intensity of the light comparable to the average summer sunlight irradiation in Florida. The temperature was kept fairly high and water was sprayed on the panels for 18 minutes out of every 2 hours.

Testing was conducted over 5,000 hours to replicate the rough equivalent of 25 years of sunlight.

The two figures provided below show the results for redness and lightness of the UV testing.

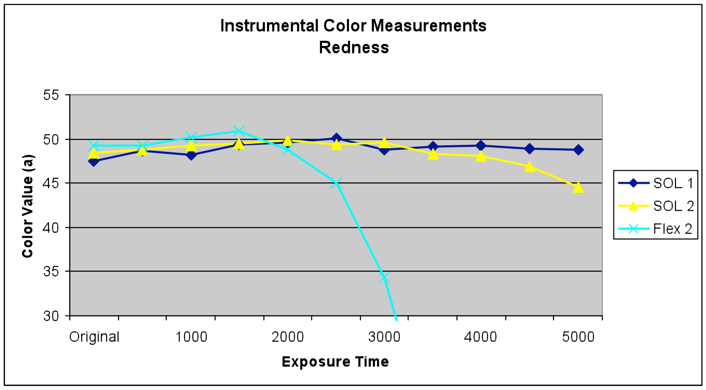

Figure 2. Redness test results

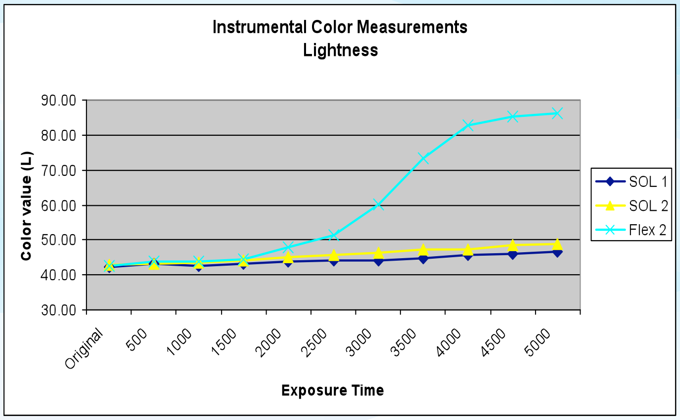

Figure 2. Lightness test results

Explanation of color measurements:

- Redness Factor: Measures the “redness” of the base color. The higher the number is, the redder the object.
- Lightness Factor: Measures fade. The higher the number is, the more the fade has occurred.

TEST 2: Salt Spray

The second test was for salt exposure or the prohesion cycle per ASTM G85 Annex 5. The test procedure included the cycling of:

- 1 hour of salt fog at ambient conditions
- 1 hour of drying at 35ºC

The fog was a fine mist of dilute salt solution with humidity close to saturation. The materials were subjected to 504 hours of continuous fogging and continuous drying. All samples passed this test.

TEST 3: Thermal Cycling

The third test was for thermal cycling, but it did not follow an ASTM test standard. During the four weeks of testing, the samples were cycled from -5ºC to 120ºC in 25 cycles with a 30 minute dwell time at each temperature causing expansion/contraction stresses. A weekly observation for delamination, cracking and bubbling was conducted. All samples passed this test.

Conclusion

1 : The results from the UV exposure test for the SOL material revealed superior performance in terms of color fastness. The Flex sample revealed significant chalking, causing the ink contrast to become significantly less legible.

2 : Additional observations during the UV testing showed that the Flex 2 sample revealed obvious shrinkage and some bronzing.

3 : The SOL samples did not reveal any sign of chalking, bubbling, shrinkage, cracking or delamination.

4 : The SOL material has built in UV inhibitors and aggressive adhesive designed to resist the rigorous outdoor elements. The premium chemicals used as additives in the SOL vinyl have a stronger internal bond, thereby mitigating the chalking and shrinking effects exhibited by the other vinyl material.

5 : The SOL samples passed the rigorous test that simulated approximately 25 years of UV exposure. This high-performance label, with UV-resistant ink and UV-resistant overlamination, will perform well when used to mark a solar photovoltaic system.

FOR MORE INFORMATION

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