Abrasion Properties of Window Films

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Date: July 3, 2014
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Author: William Stegeman
Report Number: ESP017051P-Ultra Abr
Client Purchase Order Number: USMMNNY511T

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INTRODUCTION

This report presents the results of abrasion resistance tests conducted on samples of window films. The testing was authorized by Paul Neumann of 3M Renewable Energy on June 12, 2014. The testing and data analysis were completed on September 18, 2014.

The scope of our work was limited to conducting abrasion resistance (done at another Element Lab) tests on the samples submitted and reporting the results.

OBJECTIVE

Determine abrasion properties of the window films.

SAMPLE IDENTIFICATION

The samples were identified as 3M™ Scotchshield™ Safety and Security Film Ultra 600, and Ultra 800

TEST METHOD

The specimens were allowed to condition at standard laboratory conditions of $72 \pm 4^\circ F$ and $50 \pm 5\%$ relative humidity for at least 40 hours prior to testing. Testing was done according to ASTM Standards detailed below, with notes of parameters and/or deviations.

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Test Method Title</th>
<th>Parameters and/or Deviations from Method</th>
</tr>
</thead>
</table>
| ASTM D1044  | Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion | Wheels: CS10F  
Weight: 500 g  
Cycles: 100 |

CALIBRATED TEST EQUIPMENT

Byk Gardner Haze-Gard Plus, PT-173-021, Calibration Due: Per Use
Haze standard, ID PT-173-022 - Calibration Due: 10/10/2014
Tabor Abrader, ID PT-173-024 - Calibration Due: 02/05/2015
Temp/Humidity PT-172-074 – Calibration Due: 1/31/2015
### TEST RESULTS

**Abrasion**

<table>
<thead>
<tr>
<th>Sample #</th>
<th>Haze %: Original</th>
<th>Haze %: Abraded</th>
<th>Change in Haze (% ABRASION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>600-1</td>
<td>3.69</td>
<td>6.89</td>
<td>3.20</td>
</tr>
<tr>
<td>600-2</td>
<td>4.92</td>
<td>7.58</td>
<td>2.66</td>
</tr>
<tr>
<td>600-3</td>
<td>3.59</td>
<td>6.73</td>
<td>3.17</td>
</tr>
<tr>
<td>Average</td>
<td>4.07</td>
<td>7.07</td>
<td>3.01</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.74</td>
<td>0.45</td>
<td>0.30</td>
</tr>
<tr>
<td>800-1</td>
<td>4.99</td>
<td>7.33</td>
<td>2.34</td>
</tr>
<tr>
<td>800-2</td>
<td>4.97</td>
<td>7.91</td>
<td>2.94</td>
</tr>
<tr>
<td>800-3</td>
<td>4.24</td>
<td>77.60</td>
<td>3.36</td>
</tr>
<tr>
<td>Average</td>
<td>4.73</td>
<td>30.95</td>
<td>2.88</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.43</td>
<td>40.40</td>
<td>0.51</td>
</tr>
</tbody>
</table>

Respectfully submitted,

[Signature]

William Stegeman  
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