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Cover Page

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Testing and Evaluation of C-Bond Systems Solutions: Peel Tests

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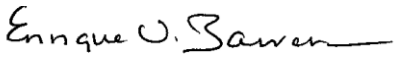

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Synopsis:

Peel test data for C-Bond I and II solutions have been produced and are reported in this report. Solutions are made and applied to glass plates for peel testing. Data using C-Bond I and II as the application solution were compared to data using soap and water as the counterpart method of applying film to glass.

This report was written by Dr. E. V. Barrera, Professor at Rice University.
Dr. Barrera serves as Chief Technology Officer to C-Bond Systems.
US Customary Units are used in this report.

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Abstract

C-Bond Solutions are glass strengthening and adhesion promoting solutions. Previous reports for C-Bond I and C-Bond II focused on glass strengthening and indicated strengthening for C-Bond I of 80% and for C-Bond II up to 250%.
This report is focused on the adhesion promotion properties provided by C-Bond. Testing using standard methods has shown that C-Bond solutions provide up to 300% improvement in adhesion promotion.

Introduction

C-Bond Systems produces solutions that are designed to work with glass and film. This is to say that glass, particularly architecture glass can have film applied with C-Bond solutions as a superior method to that of using soap and water (the industry standard) to apply the film to the glass. The C-Bond solutions are designed to provide superior properties compared to the soap and water application solution. Rice University under the direction of Dr. Enrique V. Barrera conducted peel testing to study the adhesion properties of the C-Bond solutions. Previous reports [1-2] and technical presentations have featured how glass has been strengthened via C-Bond. Data and some of the text taken from the C-Bond Technical Report [3] haven been a source for this report. Hence, this report shows the adhesion effects of the film to the glass when C-Bond solutions are used.

C-Bond solutions, in their current use, can be described as a slip agent for applying film on glass while providing glass strengthening and adhesion promotion. A slip agent makes film easy to apply because when used, the film can be moved and positioned on the glass before the excess solution is squeegeed out. Excess solution must leave the glass/film system and should not reduce the system properties. The current soap and water slip agents do not strengthen the glass/film system. C-Bond makes the film easy to apply and strengthens the glass and/or glass/film system. This report shows the adhesion effect of C-Bond. The outcome is that by using C-Bond solutions a Glass/Film system can be produced with superior properties.

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Film Properties

Architectural film is generally a Polyester (PET) polymer. Some films are designed to release moisture along with other properties such as solar control, glare reduction, energy saving, UV reduction, decorative and scratch resistance. The film product is designed to stick to the glass using a Pressure Sensitive Adhesive (PSA) which is generally an acrylic-based adhesive having additives for coupling to glass. PSAs vary in properties for different film companies but all are designed to work with water-based slip agents at room temperatures or over a range of temperatures. Film companies typically purchase the film (PET) and then apply their own PSA while other companies engineer the whole product. The PSAs are designed to not change the films optical properties over time. Film products also carry manufacturer warranties, in some cases for 10 or more years. Companies offer different film thicknesses for various applications. Additionally, some films can be deteriorated by certain cleaning solutions. Figure 1 shows a Film/PSA/C-Bond/Glass system illustrating where C-Bond will be applied to adhere the film to the glass.

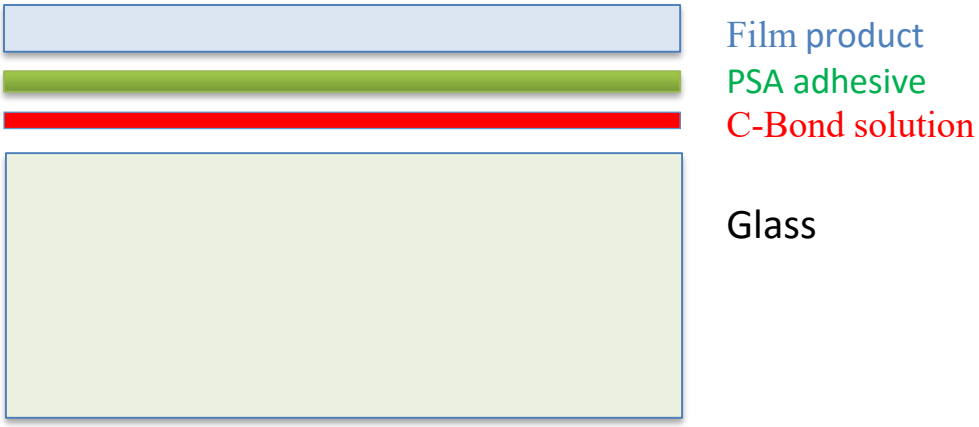

Figure 1. (Top down) Film with PSA underneath is applied to glass (bottom) by using C-Bond between the PSA and the glass. The excess solution is squeegeed out and the remaining solution evaporates either through the film or out of the film edges.

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Peel Testing

The standard peel test using ASTM C3330 does not specify the substrate but only suggests that various metal plates are used. The standard does not require that a slip agent is used to apply the film. The standard requires the test be performed within 1 min of applying the adhesive tape. The tests in this report differ in that the tests were conducted using glass as the substrate and either soap and water or C-Bond solutions as the slip agent.

Peel testing is a method of pulling away a coating or film on a substrate to determine adhesion properties of the system. Standard testing methods include ASTM C3330 which is identified for evaluating film on glass related to architectural systems. For peel testing a number of angles can be used but typical angles for a glass to film system are 90° and 180°.

Figure 2 shows peel tests results for C-Bond II. Data using 3 top film manufacturers (Hanita, Madico, and Suntek) film products on flat soda lime glass are shown. Data for film applied to glass using soap and water versus using C-Bond II is shown. Note that for both the 90° and 180° peel tests strengthening is seen for C-Bond over the strength using soap and water. Strengthening for the 90° peel shows an average increase of 110% while strengthening for the 180° peel test shows an average increase of 300% over soap and water.

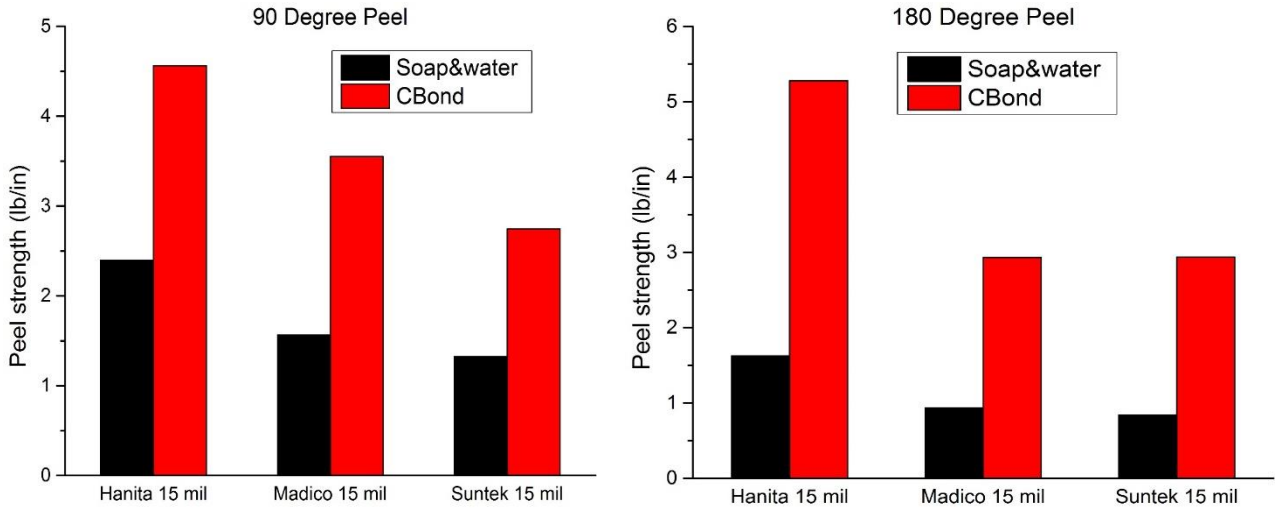

Figure 2. Peel test data using C-Bond II as compared to data using soap and water.

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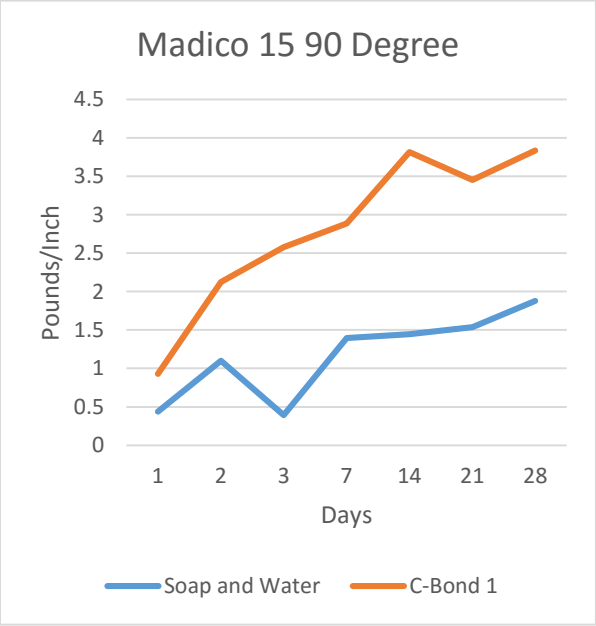
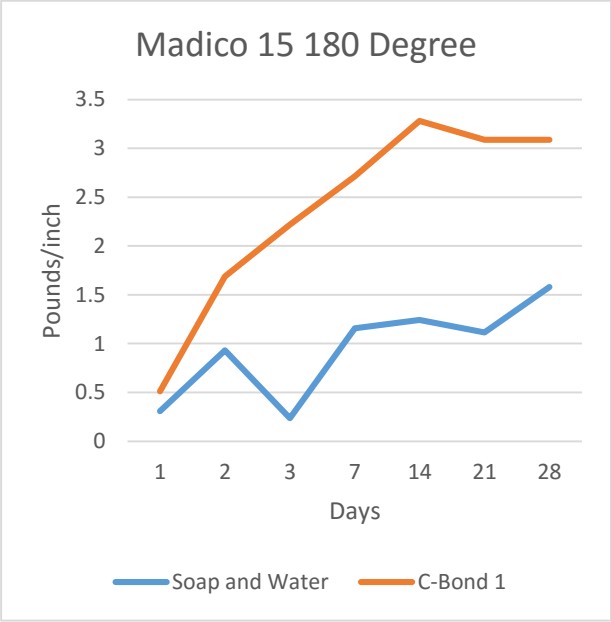
Timed Peel Testing

Film when applied with soap and water cures periodically over time before reaching its final adhesive strength. Peel tests were conducted over a period of 28 days to determine the curing time of film applied with both soap and water versus C-Bond I and II solutions.

Figure 4 shows a number of peel tests that were conducted where the PSA is allowed to bond and cure to the glass over different time intervals. For each of these curves, C-Bond solutions show superior behavior to film applied with soap and water. The important comparisons are that in each case the adhesion properties of C-Bond are greater than soap and water and that C-Bond reaches higher adhesive strength faster than soap and water. It is also important to identify that C-Bond provides significantly higher strength than soap and water during the entire duration of the cure period and it's clearly apparent that soap and water never reaches the adhesive strength of film applied with C-Bond solutions.

CB I vs S&W





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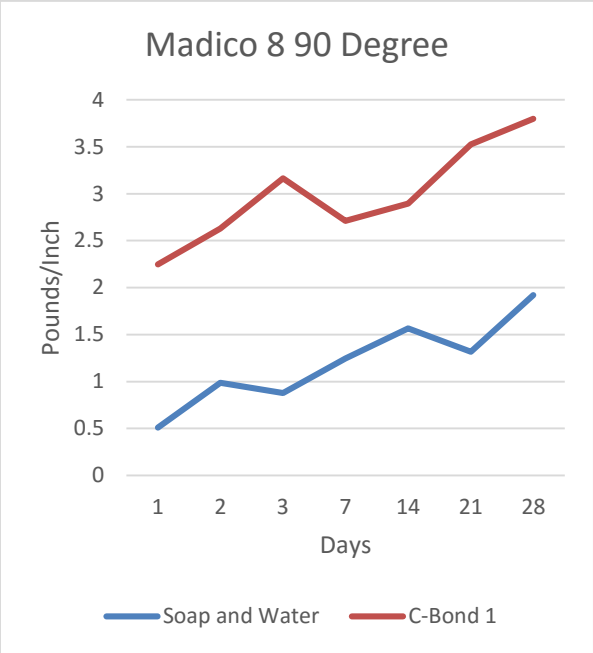
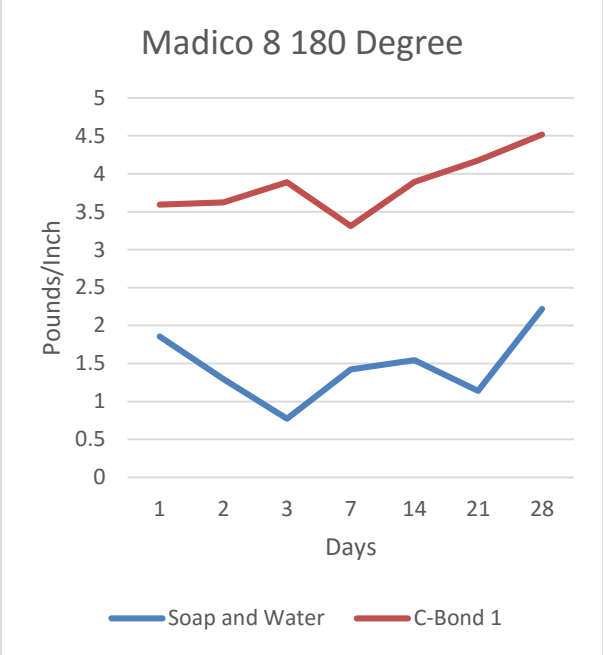
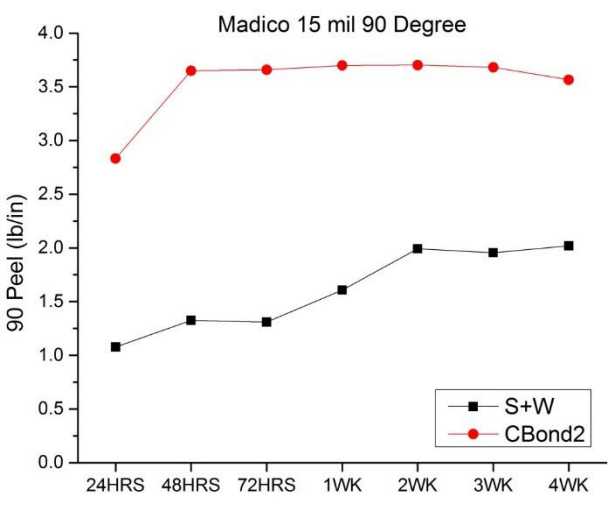




CB II vs S&W



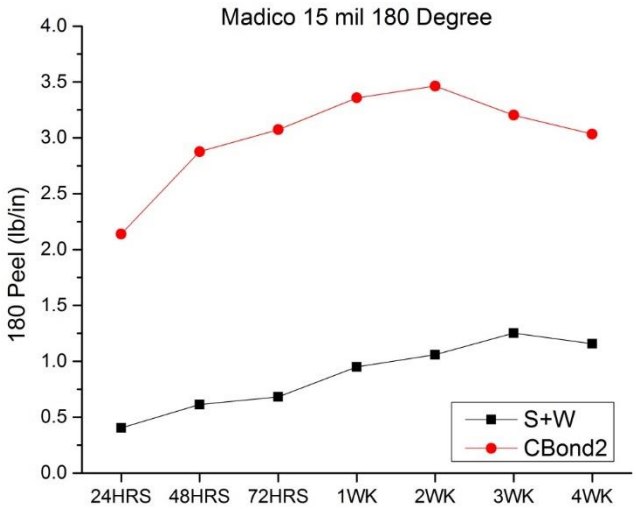


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Figure 4. Timed peel tests for film applied on glass using C-Bond I and C-Bond II compared to test results for film applied on glass using soap and water.

Research Team

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3. CBondTechnicalPresentationEVB.pptx

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