Simulated divided lites continue to be a desirable design option for residential windows in North America. In fact, you probably use them in your products. Estimates by Fry Consulting Inc. show that more than 90 percent of manufacturers include some type of grids. Up to 62 percent of these companies use a pressure-sensitive foam or extruded tape as the primary means of attachment. Given the increasing performance requirements of this application, manufacturers are seeking a more robust tape product that is designed specifically for attaching simulated divided lites. To begin development of a pressure-sensitive adhesive tape, new performance tests and methods must be defined to help simulate desirable performance properties for window manufacturers. That’s where companies such as ours come in as window manufacturers have enough to worry about.

The formulation and composition of pressure-sensitive adhesive (PSA) foam tapes utilized by window manufacturers for the construction and assembly of muntin bar applications has remained relatively the same for decades. For years, manufacturers have utilized industrial-grade foam PSAs that were sufficient, in most cases, for this application. However, as the demand for improved window aesthetics has increased, so, too, have the design and performance expectations of adhered muntin bars. Humidity, thermal influences and laminating pressure during application are a few factors that influence performance and durability of the adhered muntin bars over time. Lifting and bowing are two common problems affecting the appearance of simulated divided lites (SDLs), so manufacturers are interested in finding a higher-performing, more robust adhesive foam tape designed for optimum performance in this unique application.

Because window manufacturers do not have extensive knowledge in qualifying adhesives to determine the physical properties that are truly important to this application, they are turning to adhesive manufacturers to learn more about what tests are most relevant for their applications.

Our company is helping manufacturers address this need. We interviewed a variety of window manufacturers for more than a year to understand the intricacies of the muntin application. Through this evaluation, we have identified and developed more appropriate physical testing to qualify adhesives for...
While these standard tests are useful and reliable when comparing similar products ... they are not always the best predictors for measuring the forces tape-applied muntin bars will experience in the field.

Understanding Conventional Tape Tests

Manufacturers of PSAs rely typically on a combination of peel, shear, tack and liner release tests to characterize adhesive performance. Peel strength is a critical quality control test and is considered to be a general indicator of “bond strength” for tape systems. Peel strength testing involves measuring the force required to remove the tape after it has been applied to a standard test panel, usually stainless steel.

Shear most commonly is measured using a static dead load while observing the time it takes for the tape to fail. In this test, a prescribed weight is attached to a tape overlap (often ½ x ½ inches or 1 x 1 inches) adhered to a fixed panel and the time it takes the tape to move is recorded. The measurement in days, hours or minutes is an indicator of the adhesive’s resistance to creep and extension, or shear strength. An ideal shear test will result in cohesive failure mode of the adhesive, thereby truly characterizing the internal strength of the system. This test also can be run at elevated temperatures and humidity to evaluate performance changes in varying environments.

Tack is essentially the tape’s ability to “wet-out” on a surface quickly. The faster it wets the surface, the better the tack. Most of us experience tack with our fingers when we touch the surface of a tape the more resistance we feel as pull our fingers away, the higher performance we perceive the tape to have. Quantitatively, manufacturers rely on texture analysis, loop tack, rolling ball or probe tack to measure tack properties.

Last, the force required to remove the release liner that is common to most tape systems often is measured to ensure functionality. Because the release liner is removed and discarded prior to muntin bar installation, it is not critical to field performance for this application.

While these standard tests are extremely useful and reliable when comparing similar products or as part of a quality control process, they are not always the best predictors themselves for measuring the forces tape-applied muntin bars will experience in the field.

Factory Assembly of Muntin Bars

PSA foam tapes are utilized in two applications within a muntin installation. The first is to apply the bar lineal by using an automatic applicator, semi-automatic applicator or hand roller. The bar may be applied to wood (often painted or treated with a water-resistant primer), painted aluminum or various grades of PVC or polymer alloys. This is one application in particular where tack and peel performance must be paired appropriately. Many tape systems on the market today demonstrate adequate adhesion to these surfaces, which is demonstrated easily by trying to remove the tape after applying and short “dwell,” or resting, times. Most tapes will resist removal from these surfaces to the point that the tape will be destroyed or distort severely if removal is attempted.

The second application occurs when the taped bar is installed on the window after being sized, cut and mitered. This installation requires a different range of performance properties because it is a rigid-to-rigid lamination. Tapes selected for this application should demonstrate excellent wet-out, or smooth, consistent adhesion across the surface without pockets of air between the surface and foam substrates. Once the tape is applied, the taped bars must be sized correctly and installed. Variables that must be kept in mind at this stage include:

- Bars can be cut too long, resulting in high tensile forces and bowing;
- Relative humidity (RH) expansion and contraction on wood bars can cause lifting;
- Thermal expansion and contraction on aluminum bars and PVC can affect adhesion; and
- Excessive lamination pressure may cause warping or bowing.

Once the taped bars are assembled and the window is installed, it is required to perform consistently in varying temperatures, ultraviolet exposures, humidity and moisture. The adhered bars must perform under the additional physical stress that occurs during handling and installation by the contractor, and finally, withstand the ongoing stress that occurs when homeowner...

continued on page 36
ers open or close the window by pulling on the bars. This type of physical stress results in high shear forces that are not accurately represented by the typical physical tests performed on PSAs.

**Defining a New Adhesive Solution**

In order to formulate an adhesive chemistry and tape construction for optimum performance, the first step was to develop a new approach to predictive performance testing specific to the muntin bar application.

Based on field feedback, our researchers identified two new product performance tests deemed as the most critical for the muntin bar application the Z-tensile and dynamic shear tests. The Z-tensile test evaluates a tape’s ability to resist forces that could pull the grille away from the glass over time, such as thermal or humidity expansion. The dynamic shear test demonstrates the strength needed to withstand significant angled forces to simulate a homeowner using the muntin bar to open or close the window. These tests also may evaluate how the PSA is affected by temperature extremes and high relative humidity over time.

We compared how our products, and others on the market, performed in these tests to identify areas for improvement. Following this evaluation, we developed a custom adhesive polymer designed to resist stress, fatigue, vibration, temperature cycling, moisture and ultraviolet exposure more aggressively. Additionally, a new foam substrate was selected to offer a smoother surface for improved wet-out to seal out most contaminates before and after installation.

The performance demands for PSAs used to adhere muntin bars in SDL applications can be extreme. For long-term performance, the adhesive must resist a variety of conditions. Window manufacturers can benefit by understanding the performance requirements of their application and correlating these with appropriate product testing of the PSAs they are considering.

Michael D. Martin is the technical services manager for Adhesives Research Inc. based in Glen Rock, Pa.