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Application Note

Calculated Thickness vs. Measured Thickness

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The results of overall thickness measurements in laminated multilayer panels are often different from what was expected, due to micrometer or cross-section readings in one specific area (usually a coupon), as opposed to examining at the entire panel.

Panels are typically never truly flat or consistent across the entire surface. Usually, panels are thicker in the center and taper to the thinnest spots near its corners, (often described at the "football" shape of a panel). Average readings do not work well because a segment of any panel is not representative of its actual area total, relative to the entire panel area.

In any given square or rectangular panel, the shape the actual flow dynamic taking place is more like a series of concentric circles over laying the panel. Imagine a bulls eye is in the center and each circle outside and concentric to that center point will be either equal to, or more likely less than, the thickness of that center point. The thickness distribution over a panel surface is typically the thickest point in the center, its thinnest in each of the corners and its next thinnest along the center of each edge, The degree of taper is dependent on the interaction between the construction and the lamination process. Micrometer readings are usually taken near the panel edge, so it is not unusual to see lab reports showing panels to be thinner than expected.

Taper will worsen with lower pressures, higher unsupported resin volume and lower rise rates. It can be significantly influenced by warped tooling plates where the edges of those tooling plates make contact first and result in reduced pressure and thermal transfer near the center of the panel.

Taper can be reduced by increasing pressure to a threshold level to remove the warp from the tooling plates. This creates effective thermal and pressure transfer to increase the rate of rise to a point (appropriate to the selected PSI range) which increases the flow from the center of the panel and in rare cases, reduces the total unsupported resin volume present in a construction.

It is possible to achieve flatter panels (less taper) by using smaller sheets of craft paper in the center of the book, usually one piece about 33% smaller than the panel size and a second piece about 66% smaller. The effect slightly increases the pressure in the center of the panel to encourage flow from the center, where almost no actual flow takes place, toward the outer edges of the panel where the most flow takes place.

Regardless of the lamination process, construction or methods used to reduce taper, it is important to understand the thickness you have achieved relative to the thickness in your original calculations. The only accurate method to compare micrometer thickness to calculated thickness is to measure the thickness across the diagonal of a panel and normalize those thickness readings to compensate for the total panel area each of those micrometer readings represents.

To get the most accurate micrometer reading, measure across the diagonal of the panel and locate the center. Then identify three spots on each side of the center. You now have seven readings to reference. Enter the data into the Isola's "normalization" spreadsheet to view your "normalized thickness" data and graph depicting the actual profile of the thickness variation. This tool can help you better assess the overall thickness that you need to achieve and monitor the effectiveness of process changes intended to realize less taper in your panels.