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Technical Bulletin—Substrate Selection

Wilsonart International—Technical Services

Overview of this Bulletin

In this technical bulletin we will discuss:

- Substrate types
- Substrate characteristics
- Selection criteria based on your project

Substrates

The term substrate (*substratum*), as it applies to High Pressure Decorative Laminate (HPDL), refers to the **structurally supportive material that a laminate is bonded to**.

In order to understand Substrates, you need to understand Laminate. HPDL is composed of resin impregnated kraft paper with decorative paper face material and a clear protective top layer which are fused under high heat and pressure. **HPDL sheets are primarily composed of more than 70% alpha-cellulose (wood) fibers!**

In selecting the appropriate Substrate for Laminate, it's smart to consider the typical dimensional characteristics of wood.

There are two Substrate types generally recognized by the industry as "recommended" for use with Laminate. **Particleboard** or **medium/high-density fiberboard (MDF/HDF)** substrates are all technically well-suited to HPDL.

Other materials such as plywood, steel, or aluminum may be used in some applications, but their dimensional characteristics (movement during climatic change) are significantly different than the laminate that will be applied to them. This can create issues after installation.

Gypsum-board (sheet rock), plaster, and similar materials are <u>not</u> suitable due to low internal bond and differences in dimensional change.

Composite wood panels include particleboard, MDF, and plywood. Differences in characteris-

Inside this issue:

Overview—Composite Panels

The two main categories of recommended HPDL substrates include **particleboard** and **medium-density fiberboard**. Both of these products have somewhat random grain-structure that gives them dimensional characteristics similar to laminate. Specific advantages of each should be considered when you are selecting the best option for your application.

Particleboard is a composite panel product consisting of cellulosic particles of various sizes that are bonded together with a synthetic resin or binder under heat and pressure. Particle geometry, resin levels, board density and manufacturing processes may be modified to produce products suitable for specific end uses.

There are various grades of Particleboard available with differences in density and performance (see table page 2). Performance additives can impart greater dimensional stability, increased fire retardance and moisture resistance. Particleboard is usually an economical choice. Moderate product weight and good "screw-holding" strength are other advantages.

(Continued on page 2)

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Overview—Composite Panels (continued from page 1)

Particleboard and MDF materials are offered in a variety of grades depending on the application needs.

MDF is also a composite panel product typically consisting of cellulosic fibers combined with a synthetic resin or other suitable bonding system and joined together under heat and pressure. Additives during manufacturing can impart other characteristics.

The surface of MDF is flat, smooth, uniform, dense and free of knots and grain patterns. These surface characteristics make MDF a good choice for more glossy HPDL. The homogeneous density profile of MDF allows for intricate and precise machining of edges. Consider physical characteristics and mechanical properties when selecting MDF. Due to the fiber content and orientation, the dimensional characteristics are somewhat similar to HPDL.

PARTICLEBOARD: PHYSICAL & MECHANICAL PROPERTY REQUIREMENTS

GRADE	LENGTH AND WIDTH MM (INCHES)	THICKNESS TOLERANCE		PHYSICAL AND MECHANICAL PROPERTIES			SCREW-HOLDING		FORMALDEHYDE (PPM)
ANSI A208.1-1999 Particleboard		Panel Average from Nominal mm (inches)	Variance from Panel Average mm (inches)	Modulus of Rupture N/mm2 (psi)	Modulus of Elasticity N/mm2 (psi)	Internal Bond N/mm2 (psi)	Face N (pounds)	Edge N (pounds)	
H-1	+2.0 (0.080)	+.200 (0.008)	+0.100 (0.004)	16.5 (2393)	2400 (348100)	0.90 (130)	1800 (405)	1325 (298)	0.30
H-2	+2.0 (0.080)	+.200 (0.008)	+0.100 (0.004)	20.5 (2973)	2400 (348100)	0.90 (130)	1900 (427)	1550 (348)	0.30
H-3	+2.0 (0.080)	+.200 (0.008)	+0.100 (0.004)	23.5 (3408)	2750 (398900)	1.00 (145)	2000 (450)	1550 (348)	0.30
M-1	+2.0 (0.080)	+.250 (0.010)	+0.125 (0.005)	11.0 (1595)	1725 (250200)	0.40 (58)	NS	NS	0.30
M-S	+2.0 (0.080)	+.250 (0.010)	+0.125 (0.005)	12.5 (1813)	1900 (275600)	0.40 (58)	900 (202)	800 (180)	0.30
M-2	+2.0 (0.080)	+.200 (0.008)	+0.100 (0.004)	14.5 (2103)	2250 (326300)	0.45 (65)	1000 (225)	900 (202)	0.30
M-3	+2.0 (0.080)	+.200 (0.008)	+0.100 (0.004)	16.5 (2393)	2750 (398900)	0.55 (80)	1100 (247)	1000 (225)	0.30
LD-1	+2.0 (0.080)	+.125 (0.005) -.375 (0.015)	+0.125 (0.005)	3.0 (435)	550 (79800)	0.10 (15)	400 (90)	NS	0.30
LD-2	+2.0 (0.080)	+.125 (0.005) -.375 (0.015)	+0.125 (0.005)	5.0 (725)	1025 (148700)	0.15 (22)	550 (124)	NS	0.30
PBU	+0.0 (0) -4.0 (0.160)	+0.375 (0.015)	+0.250 (0.010)	11.0 (1595)	1725 (250200)	0.40 (58)	NS	NS	0.20
D-2	+2.0 (0.080)	+0.375 (0.015)	+0.250 (0.010)	16.5 (2393)	2750 (398900)	0.55 (80)	NS	NS	0.20
D-3	+2.0 (0.080)	+0.375 (0.015)	+0.250 (0.010)	19.5 (2828)	3100 (449600)	0.55 (80)	NS	NS	0.20

MDF: PHYSICAL & MECHANICAL PROPERTY REQUIREMENTS

GRADES	PHYSICAL AND MECHANICAL PROPERTIES											
ANSI A208.2-2002 MDF	Modulus of Rupture (MOR)		Modulus of Elasticity (MOE)		Internal Bond (IB)		Screw-holding				Thickness Swell (TS) Panel Thickness	
	N/Mmm²	(psi)	N/Mmm²	(psi)	N/Mmm²	(psi)	Face N	(pounds)	Edge N	(pounds)	<15mm mm (inch)	>15mm percent
110	14.0	2030	1400	203100	0.30	44	780	175	670	151	1.5 (0.059)	10%
120	14.0	2030	1400	203100	0.50	73	875	197	775	174	1.5 (0.059)	10%
130	24.0	3481	2400	348100	0.60	87	1100	247	875	197	1.5 (0.059)	10%
140	24.0	3481	2400	348100	0.75	109	1325	298	1000	225	1.5 (0.059)	10%
150	31.0	4496	3100	449600	0.90	131	1400	315	1200	270	1.5 (0.059)	10%
160	31.0	4496	3100	449600	1.05	152	1555	350	1335	300	1.5 (0.059)	10%

THIN MDF: PHYSICAL & MECHANICAL PROPERTY REQUIREMENTS

GRADES	PHYSICAL AND MECHANICAL PROPERTIES				
ANSI A208.2-2002 MDF	Modulus of Rupture (MOR)		Internal Bond (IB)		Thickness Swell (TS)
	N/Mmm²	(psi)	N/Mmm²	(psi)	mm (inch)
210	21.0	3046	0.35	51	2.0 (0.080)
220	31.0	4496	0.60	87	2.0 (0.080)
230	31.0	4496	1.00	145	2.0 (0.080)
240	45.0	6527	1.50	218	2.0 (0.080)

MDF: OTHER REQUIREMENTS

PROPERTIES	TOLERANCE LIMITS
Panel Length or Width > 0.61 m (2 feet)	+ 2.0 mm (0.080 inch)
Panel Average from Specified Thickness	+ 0.125 mm (0.005 inch)
Variance from Panel Average Thickness	+ 0.125 mm (0.005 inch)
Linear Expansion (LE)	< 0.3 percent
Formaldehyde Emissions	< 0.30 ppm

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Other Marginal Substrates

Plywood, Steel, Aluminum, Fiber Reinforced Plastic (FRP) may be used in some applications, but their dimensional movement is significantly different from HPDL. This may result in panel warpage, stress cracking and open seams.

Plywood is a type of engineered wood made from thin sheets of wood, called plies or wood veneers. The layers are glued together, each with its grain at right angles for greater strength. There are usually an odd number of plies, as the symmetry makes the board less prone to warping.

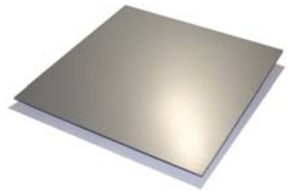
Hardwood plywood is used for some demanding end uses.

Birch plywood is characterized by its excellent strength, stiffness and resistance to creep. It has high planar shear strength and impact resistance, which make it well-suited for heavy-duty floor and wall structures.

Decorative plywood is usually faced with hardwood (red oak, birch, maple, lauan or Philippine mahogany are most common).

The "cross banding" of the plies restricts dimensional change resulting in less movement during humidity swings. However, variation in graining and density tend to make plywood a bad choice for higher gloss level HPDL due to telegraphing (substrate imperfections "show through").

Steel/Aluminum are used for high structural/performance demand projects. Although internal bond is not an issue, metal substrate dimensional change is completely relative to temperature. In contrast HPDL dimensional change is primarily humidity driven (hygroscopic). As a result, ambient conditions may make



components move in opposite directions.

Additionally, there are specific challenges when bonding the metal and HPDL. The non-porous nature of steel limits the use of adhesives that require evaporation. Oxidation can occur after bonding.

Similar to metal, FRP has thermal dimensional characteristics that can work at odds with HPDL. Additionally, composition variability may make it difficult to find compatible adhesives for bonding with HPDL.

The integrity of a bonded assembly is only as good as the weakest component. Limited bonding window, delamination, telegraphing, warpage, and stress cracking are more likely when marginal or poor substrates are selected.

Substrates to Avoid

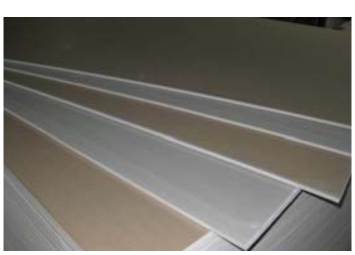
Gypsum board (Plasterboard/Drywall), Plaster, Concrete and similar material are not recommended as substrates because their internal bond is inadequate for HPDL applications.

Gypsum board, (Plasterboard/Drywall) is a panel made of Gypsum plaster pressed between two thick sheets of paper. Both the paper and the gypsum core have low internal bond strength compared to particleboard or MDF.

Plaster is also characterized by low or irregular internal bond strength. Surface irregularities may also result in telegraphing (especially on higher gloss HPDL finishes).

Concrete surfaces are prone to loose particles or contaminates. The internal bond can be irregular and is prone to moisture transfer. Dimensional characteristics are primarily thermally driven. Surface irregularities can result in telegraphing.

Old/Existing Laminate or Thermofused Melamine should also be avoided due to poor surface adhesion characteristics of a melamine surface. This type of application is prone to solvent entrapment and dimensional change issues.



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Particleboard

- Economical with compatible dimensional characteristics.
- Variations in surface flatness. Surface quality should be routinely monitored. (watch for sanding chatter/thickness variations)
- Vertical density profile irregularities can contribute to warpage.
- Cut edges are a source for chips and contaminates during bonding operations.

MDF

- Good surface flatness in most cases with compatible dimensional characteristics.
- Surface must be suitable for bonding.

Plywood

- Dimensional characteristics are not consistent with HPDL.
- Irregular surface of face veneer (graining) can telegraph (especially on thinner laminate grades).
- Thickness inconsistency can result is difficulty to apply even adhesive coverage.
- Thickness inconsistency can result is irregular applied pressure in pressing processes. Thickness consistency can change as the substrates moisture content changes.
- Differences in moisture content, or nature of face veneers can create a challenge to predict adhesive dry time and/or necessary adhesive loading.
- Adhesive layers between plies can interfere with adhesive drying time (especially with thinner face veneers and/or HPL liner grade products).

Moisture Resistant Types (Particleboard/MDF/Plywood)

- Moisture inhibitors can interfere with PVA bonding/drying. Check with substrate supplier for adhesive-type recommendations. This may also require your own trials.

Fire Resistant Types (Particleboard/MDF/Plywood)

- Fire retardant additives may be incompatible with some or all PVA adhesives. Always confirm that your adhesive is compatible with the substrate supplier.

Gypsum board

- Inadequate internal bond for HPDL.

Old/Existing HPDL or Low-pressure Melamine (TFM)

- Poor surface adhesion characteristics.
- Solvent entrapment.
- Prone to dimensional change issues.

If you have questions about the use of any substrate with Wilsonart Laminates, please contact the Technical Services department, or call toll-free 800-433-3222.

Special thanks to:

Composite Panel Association

www.pbmdf.com