Entwicklungs- und Prüflabor Holztechnologie GmbH
Zellescher Weg 24
01217 Dresden · Germany

Telefon + 49 351 4662 0
Telefax + 49 351 4662 211

E-mail info@eph-dresden.de
Internet www.eph-dresden.de

Entwicklungs- und Prüflabor Holztechnologie GmbH · Zellescher Weg 24 · 01217 Dresden

MELATONE LTD.
Mr. Leo Kim
692-10, GOJAN-DONG, NAMDONG-KU
INCHEON
KOREA

Dresden, 22 November 2013
70-em/pe

# Test report
# Order No. 2713497

| | |
|---|---|
| **Customer:** | MELATONE LTD.<br>692-10, GOJAN-DONG, NAMDONG-KU<br>INCHEON<br>KOREA |
| **Date of order:** | 22 October 2013 |
| **Order:** | Carrying out of tests on HPL (high pressure laminate) |
| **Institution:** | EPH – Laboratory Surface Testing |
| **Engineer in charge:** | Dipl.-Ing. (FH) M. Peter |

Dr.-Ing. R. Emmler
Head of Laboratory Surface Testing

The test report contains 10 pages. Any duplication, even in part, requires written permission of EPH. These test results are exclusively related to the tested material.

# 1 Task

The authorized laboratory Entwicklungs- und Prüflabor für Holztechnologie GmbH (EPH) was ordered by MELATONE LTD. in INCHEON / KOREA to carry out several tests on HPL (high pressure laminate).

# 2 Material

For the tests, the customer has sent the following variant of HPL (high pressure laminate) (entrance at the EPH laboratory on 01 November 2013):

"Decorative HPL"
Thickness: 0.7 mm

The sample preparation on wood chipboard according to EN 438-2, 20.2.1 with the specified adhesive according to EN 438-2, 20.2.2. was carried out at the EPH-laboratory.

# 3 Test performance

## 3.1 Determination of the resistance against abrasion

The test was carried out according to EN 438-2:2005 part 10 with a Taber-Abraser-Type 5151. The related test wheels were prepared with sanding paper type S42.

## 3.2 Determination of the impact resistance with small ball

The test was carried out according to according to EN 438-2:2005 part 20 with the small ball with equipment according to the standard.

## 3.3 Determination of the impact resistance with big ball

The test was carried out according to according to EN 438-2:2005 part 21 with the big ball with equipment according to the standard.

## 3.4 Determination of the resistance against dry heat

The test was carried out according to according to EN 438-2:2005 part 16.

## 3.5 Determination of resistance to scratching

The resistance to scratching according to EN 438-2:2005 part 25 was carried out an Universal Scratch Tester Model 413 (Erichsen).

### 3.6 Determination of the resistance against wet heat

The test of the resistance against wet heat was carried out according to EN 12721 (100 °C).

### 3.7 Determination of the resistance to immersion in boiling water

The test for determination of resistance to immersion in boiling water was carried out according to EN 438-2:2005, part 12.

### 3.8 Determination of the dimension stability at high temperature

The test for determination of dimension stability at high temperature was carried out according to EN 438-2:2005 part 17.

### 3.9 Determination of the resistance against staining

The test was carried out with the indicated test substances of EN 438-2:2005 part 26.

### 3.10 Determination of the light fastness

The test was carried out according to EN 438-2:2005, part 27 in a Weather Ometer Ci 3000 (Xenon arc irradiation behind 3 mm thick window glass). The test was carried out until the rating 6 of the blue wool scale according to EN 20105, B02 was reached. The grey scale according ISO 105-A02 was used for the visual inspection.

### 3.11 Determination of the resistance against water vapour

The test was carried out according to according to EN 438-2:2005 part 14.

### 3.12 Determination of the resistance against cigarette burn

The test was carried out according to EN 438-2:2005 part 30 with the cigarette sort “Marlboro”.

### 3.13 Determination of the density

The density was determined according to EN 323 “Wood based panels – Determination of density”. 10 specimens of 50 mm x 50 mm x thickness were tested. The density was calculated by the use of measured values of length, width, thickness and mass of the specimens.

### 3.14 Determination of the resistance against cracking under stress

The test was carried out according to according to EN 438-2:2005 part 23.

### 3.15 Determination of Formability (Method B)

The test was carried out according to EN 438-2:2005 part 32 method B.
Four specimens (two of them in production direction and two of them transversely to this direction) were heated with an infrared lamp for 27 seconds at appr. 150 °C (instructions of the client).
The specimens were bent using a forming equipment acc. to the requirements of EN 438-3 table 6 around a radius of 6 mm with the bending axis parallel to the fibre direction (≤ 10 × nominal thickness of the laminate), and of 12 mm with the bending axis transversely to the fibre direction (≤ 20 × nominal thickness of the laminate).
The post-formed specimens were visually examined for cracking, blistering, crazing, or discoloration.

### 3.16 Determination of the resistance to blistering (Method B)

The test was carried out according to according to EN 438-2: 2005 part 34 Methode B.

## 4 Results

### 4.1 Resistance against abrasion

| Number of revolutions until | | Resistance against abrasion IP + FP / 2 |
|---|---|---|
| IP value | FP value | |
| 240 | 680 | 460 |

### 4.2 Impact resistance with small ball

| Impact resistance (small ball) according to EN 438-2:2005 in N (n=3) |
|---|
| 29 |

### 4.3 Impact resistance with big ball

| Impact resistance (big ball) according to EN 438-2:2005 in mm (n=3) |
|---|
| 1800 |

## 4.4 Resistance against dry heat

| Result of the visual examination according to EN 438-2:2005 in rating by 160°C (180°C) |
|---|
| 5 |

Rating 5 no visible change
Rating 4 slight change of gloss and/or colour, only visible at certain viewing angles
Rating 3 moderate change of gloss and/or colour
Rating 2 marked change of gloss and/or colour
Rating 1 surface damage and/or blistering

## 4.5 Resistance to scratching

| Scratching load in N leading to double rings with ≥ 90% closeness | Sratch resistance according to EN 438-2:2005 in rating |
|---|---|
| 6 | 4 |

Rating 5 > 6,0 N
Rating 4 6,0 N
Rating 3 4,0 N
Rating 2 2,0 N
Rating 1 1,0 N

## 4.6 Resistance against wet heat

| Results of the visual examination according to EN 12721 in rating by 100°C |
|---|
| 5 |

Rating 5 *No change*
A difference between the test area and the adjoining area cannot be detected.

Rating 4 *Slight change*
The test area can only be differentiated from the adjoining area if the light source is reflected from the test area back to the inspector's eye, e.g. discolouration, changes in gloss or colour.
No changes in the structure of the surface, e.g. swelling, fibres rising, cracking, blistering

Rating 3 *Moderate change*
The test area can be differentiated from the adjoining area, visible from various perspectives, e.g. discolouration, changes in gloss or colour.
No changes in the structure of the surface, e.g. swelling, fibres rising, cracking, blistering

Rating 2 *Considerable change*
The test area can be clearly differentiated from the adjoining area, visible from all perspectives, e.g. discolouration, changes in gloss or colour, and/or the surface structure has slightly modified, e.g. by swelling, fibres rising, cracking, blistering

Rating 1 *Strong change*
The surface structure has clearly changed
and/or discolouring, changes in gloss or colour
and/or the surface material has loosened partially or completely

## 4.7 Resistance to immersion in boiling water

*Visual Examination*

| Result of the visual examination according to EN 438-2:2005 in rating |
|---|
| 5 |

Rating 5 no visible change
Rating 4 slight change of gloss and/or colour, only visible at certain viewing angles
Rating 3 moderate change of gloss and/or colour
Rating 2 marked change of gloss and/or colour
Rating 1 blistering and/or delemination

*Increase of mass*

| Result of the increase of mass according to EN 438-2:2005 in % |
|---|
| 12.9 |

*Increase of thickness*

| Result of the increase of thickness according to EN 438-2:2005 in % |
|---|
| 15.0 |

## 4.8 Dimension stability at elevated temperature

| Dimension stability at elevated temperature in % | |
|---|---|
| **L (parallel)** | **T (perpendicular)** |
| 0.25 | 0.85 |

## 4.9 Resistance against staining

| Test result of the visual examination according to EN 438-2:2005 with / without covering in rating | | | | |
|---|---|---|---|---|
| **Aceton** | **Coffee** | **NaOH** | **Hydrogensuperoxyde ($H_2O_2$, 30 %)** | **Black shoe cream** |
| 5/5 | 5/5 | 5/5 | 5/5 | 5/5 |

Rating 5 no visible change
Rating 4 slight change of gloss and/or colour, only visible at certain viewing angles
Rating 3 moderate change of gloss and/or colour
Rating 2 marked change of gloss and/or colour
Rating 1 surface distortion and/or blistering

### 4.10 Light fastness

| Change of sample colour in grey scale No due to colour change of blue wool scale | | Light fastness in the level of the blue wool scale according to the criteria of EN 438-2:2005 |
|---|---|---|
| rating 4 | rating 6 | |
| 5 | 5 | > 6 |

Grey scale N° 5 no change of colour
Grey scale N° 4,5 very small change of colour
Grey scale N° 4 small change of colour
Grey scale N° 3,5 recognisable change of colour
Grey scale N° 3 clearly recognisable change of colour
Grey scale N° 2,5 very clearly recognisable change of colour
Grey scale N° 2 strong change of colour
Grey scale N° 1 very strong change of colour

### 4.11 Resistance against water vapour

| Result of the visual examination according to EN 438-2:2005 in rating |
|---|
| 4 |

Rating 5 no visible change
Rating 4 slight change of gloss and/or colour, only visible at certain viewing angles
Rating 3 moderate change of gloss and/or colour
Rating 2 marked change of gloss and/or colour
Rating 1 blistering and/or delemination

### 4.12 Resistance against cigarette burn

| Results of the visual examination according EN 438-2:2005 in rating with the cigarette type “Marlboro” |
|---|
| 5 |

Rating 5 no visible change
Rating 4 slight change of gloss only visible at certain viewing angles and/or slight brown stain
Rating 3 moderate change of gloss and/or moderate brown stain
Rating 2 severe brown mark, but no destruction of the surface
Rating 1 blistering and/or cracks

### 4.13 Density according to EN 323

| Density in g/cm³ according to EN 323 (n = 8) |
|---|
| 1.35 |

n = number of samples

### 4.14 Resistance against cracking under stress

| Result of the visual examination according to EN 438-2:2005 in rating |
|---|
| 5 |

Rating 5 No evidence of cracking.
Rating 4 Hairline cracks only visible under x 6 magnification.
Rating 3 Cracks visible with normal vision (corrected if necessary) from the edge of the hole, but not extending to either edge of the specimen.
Rating 2 A crack visible with normal vision (corrected if necessary) from the edge of the hole, extending to one edge of the specimen such that the specimen is not broken into two pieces.
Rating 1 Specimen broken into two pieces.

### 4.15 Determination of Formability (Method B)

| Test pieces | Nominal thickness in mm | Time until reaching 150 °C | Visual evaluation |
|---|---|---|---|
| **bending radius 12 mm – axis of bending at right angles to the fibre direction** | | | |
| 1 | 0.60 | 28 | No visible changes |
| 2 | 0.61 | 26 | No visible changes |
| **bending radius 6 mm – axis of bending parallel to the fibre direction** | | | |
| 1 | 0.58 | 27 | No visible changes |
| 2 | 0.60 | 27 | No visible changes |

### 4.16 Determination of the resistance to blistering (Method B)

| Test pieces | Nominal thickness in mm | Time to reach 150 °C | Time to blister-ing in sec | Temperature at blistering |
|---|---|---|---|---|
| 1 | 0.60 | 26 | 65 | 222 °C |
| 2 | 0.61 | 26 | 62 | 220 °C |
| 3 | 0.58 | 24 | 60 | 220 °C |

## 5 Evaluation

The tested variant of HPL (high pressure laminate) can be evaluated for the several properties according to EN 438-3:2005, table 5 (General requirements) and table 6 (Additional requirements) as following:

| **Property** | **Results** | | **Requirements according to EN 438-3:2005 table 5** | | |
|---|---|---|---|---|---|
| | | | **Laminate grade** | | |
| | | | **HDS HDF HDP** | **HGS HGF HGP** | **VGS VGF VGP** |
| | | | **444** | **333** | **222** |
| Resistance to surface wear (EN 438-2:2005, p. 10) | initial point:<br>wear value: | 240<br>460 | 350<br>1000<br>**not fulfilled** | 150<br>350<br>**fulfilled** | 50<br>150<br>**fulfilled** |
| Resistance to impact by small diafulfilleder ball (EN 438-25:2005, p. 20) | 29 N | | ≥ 25 N<br>**fulfilled** | ≥ 20 N<br>**fulfilled** | ≥ 15 N<br>**fulfilled** |
| Resistance to impact by large diafulfilleder ball (EN 438-25:2005, p. 21) | Drop high:<br>Indent diafulfilleder | 1800 mm<br>8 mm | ≥ 1000 mm<br>≤ 10 mm<br>**fulfilled** | ≥ 800 mm<br>≤ 10 mm<br>**fulfilled** | ≥ 800 mm<br>≤ 10 mm<br>**fulfilled** |
| Resistance to scratching (EN 438-2:2005, p. 25) | 6 N / Rating 4 | | ≥ Rating 4<br>**fulfilled** | ≥ Rating 3<br>**fulfilled** | ≥ Rating 2<br>**fulfilled** |
| Resistance to dry heat (180 °C) (EN 438-2:2005, p. 16) | gloss finish:<br>other finishes | Rating 5 | ≥ Rating 3<br>≥ Rating 4<br>**fulfilled** | ≥ Rating 3<br>≥ Rating 4<br>**fulfilled** | ≥ Rating 3<br>≥ Rating 4<br>**fulfilled** |
| Resistance to wet heat (100 °C) (EN 12721) | gloss finish:<br>other finishes | Rating 5 | ≥ Rating 3<br>≥ Rating 4<br>**fulfilled** | ≥ Rating 3<br>≥ Rating 4<br>**fulfilled** | ≥ Rating 3<br>≥ Rating 4<br>**fulfilled** |
| Resistance to immersion in boiling water (EN 438-2:2005, p. 12) | gloss finish:<br>other finishes | Rating 5 | ≥ Rating 3<br>≥ Rating 4<br>**fulfilled** | ≥ Rating 3<br>≥ Rating 4<br>**fulfilled** | ≥ Rating 3<br>≥ Rating 4<br>**fulfilled** |
| Dimension stability at elevated temperature (EN 438-2:2005, p. 17) | L<br>T | 0.25 %<br>0.85 % | ≤ 0.45 %<br>≤ 0.90 %<br>**fulfilled** | ≤ 0.55 %<br>≤ 1.05 %<br>**fulfilled** | ≤ 0.75 %<br>≤ 1.25 %<br>**fulfilled** |
| Resistance to staining (EN 438-2:20052, p. 26) | group 1 & 2:<br>group 3 | Rating 5<br>Rating 5 | ≥ Rating 5<br>≥ Rating 4<br>**fulfilled** | ≥ Rating 5<br>≥ Rating 4<br>**fulfilled** | ≥ Rating 5<br>≥ Rating 4<br>**fulfilled** |
| Light fastness (EN 438-2:2005, p. 27) | grey scale | Rating 5 | 4 - 5<br>**fulfilled** | 4 - 5<br>**fulfilled** | 4 - 5<br>**fulfilled** |
| Resistance to water vapour (EN 438-2:2005, p. 14) | gloss finish:<br>other finishes | Rating 4 | ≥ Rating 3<br>≥ Rating 4<br>**fulfilled** | ≥ Rating 3<br>≥ Rating 4<br>**fulfilled** | ≥ Rating 3<br>≥ Rating 4<br>**fulfilled** |

| Property | Results | Requirements according to EN 438-3:2005 table 5 | | |
|---|---|---|---|---|
| | | Laminate grade | | |
| | | HDS HDF HDP | HGS HGF HGP | VGS VGF VGP |
| | | 444 | 333 | 222 |
| Resistance to cigarette burns (EN 438-2:2005, p. 30) | Rating 5 | ≥ Rating 3 **fulfilled** | ≥ Rating 3 **fulfilled** | ≥ Rating 3 **fulfilled** |
| Resistance to cracking under stress (EN 438-2:2005, p. 23) | Rating 5 | ≥ Rating 4 **fulfilled** | ≥ Rating 4 **fulfilled** | ≥ Rating 4 **fulfilled** |
| Density (EN 323) | 1,35 g/cm³ | ≥ 1,35 g/cm³ **fulfilled** | ≥ 1,35 g/cm³ **fulfilled** | ≥ 1,35 g/cm³ **fulfilled** |

| Property | Results | Requirements according to EN 438-3:2005 table 6 |
|---|---|---|
| Formability (EN 438-2:2005, p. 32 Fulfilledhod B) | L[a]: 6 mm<br>T[b]: 12 mm | L[a]: ≤ 10 × laminate nominal thickness<br>T[b]: ≤ 20 × laminate nominal thickness<br>**fulfilled** |
| Determination of the resistance to blistering (EN 438-2:2005, p. 34 Fulfilledhod B) | 62 sec | ≥ 10 sec<br>**fulfilled** |

[a] L = axis of bending parallel to the fibre direction.

[b] T = axis of bending at right angles to the fibre direction.

Dipl.-Ing. (FH) M. Peter
Engineer in charge