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3M Display Materials & Systems Division

Technical Data 2016

3M™ Optically Clear Adhesive and 3M™ Contrast Enhancement Film

Step by step bubble free lamination

General Description

This bulletin describes the method of laminating rigid-to-flex or rigid-to-rigid surfaces using 3M™ Optically Clear Adhesive (OCA) or 3M™ Contrast Enhancement Film (CEF) for prototype purposes. The information presented in this bulletin should be considered representative or typical. The user is responsible for evaluating the lamination process under actual conditions of use and with the substrates intended for the customer application to determine specific process parameters necessary in the individual customer's application.

Process Overview

High quality rigid-to-rigid and rigid-to-flexible lamination requires special lamination equipment. Hand lamination is to be used only for proving concepts. The lamination process is described in detail in the next section. Substrates first need to be laminated together and inspected for entrapped air. If signs of air entrapment are observed, the laminate needs to be autoclaved to remove air. When one of the substrates is polycarbonate (PC) or Acrylic (PMMA), extra testing is required to ensure the plastic is not outgassing. Substrates such as PC and PMMA tend to absorb moisture and outgas when exposed to high temperature and high humidity, creating bubble defects in laminated parts. Plastics can be pre-baked to drive moisture out.

Required Materials

- Clean room area
- Clean rubber roller
- Work Station (vacuum table or glass table)
- Wipes (avoid using wipes with free floating fibers), Air ionizer gun, Isopropyl alcohol
- 3M™ Polyester Tape 8403 (green tape)
- Cut to size samples of 3M™ Contrast Enhancement Film (CEF) and 3M™ Optically Clear Adhesive (OCA)
- Autoclave
- Temperature/Humidity Chamber

Process Description

A brief description of lamination process is provided in the following table.

Brief Summary of Lamination Process		
Pre-bake in dry, clean oven	Temperature	85°C
(for PMMA and PC only)	Duration	2 – 5 hours
Lamination	Room	Clean Room
	Temperature	Room 24°C and above
Autoclave	Temperature	30 – 60°C
	Pressure	70-100 PSI
	Duration	20 – 60 minutes
Durability	Temperature	65°C
	Humidity	90% R.H.
	Duration	12 – 72 hours

A comprehensive description of lamination process is provided in the following section.

Step 1: Baking

Step 1 applies only to plastic substrates (e.g. PC and PMMA). In order to drive moisture out of the plastic, bake the PC and/or PMMA. The oven has to be dry, clean, and free of volatiles. Samples can be baked at 85°C for 2-5 hours, depending on the plastic thickness; the thicker the plastic, the longer it takes to remove moisture.

Step 2: Lamination

3M™ Optically Clear Adhesive (OCA) and 3M™ Contrast Enhancement Film (CEF) lamination must be done in a clean room to avoid contamination that will result in defects. Clean room class 10K or better is recommended. Temperature of 24°C and above is preferred. Make sure the substrates are clean and dry; free of dust and other contaminants. Isopropyl alcohol can be used to clean surfaces. Use ionizer gun if necessary before lamination to make sure the surface is clean.

A. Secure the first substrate. Vacuum table can be used to hold the substrate down. In the absence of a vacuum table, 3M™ Polyester Tape 8403 (green tape) can be used at the corners to hold the sample in place. Make sure all the substrates are clean.

B. Use only properly die-cut pieces with clean edges so that you do not have excess adhesive or contaminant at the perimeter. 3M provides precision die cut 3M™ Contrast Enhancement Film (CEF) to customers' specification design.

C. Remove easy liner from 3M™ Optically Clear Adhesive (OCA) or 3M™ Contrast Enhancement Film (CEF) die cut. The easy liner is the first liner that is easily removable.

D. Place a small piece of green tape on the short sides of die cut. Use another tape to remove the liner. This will help hold OCA/CEF without sticking to fingers.

Figure 1. Holding sample in place.

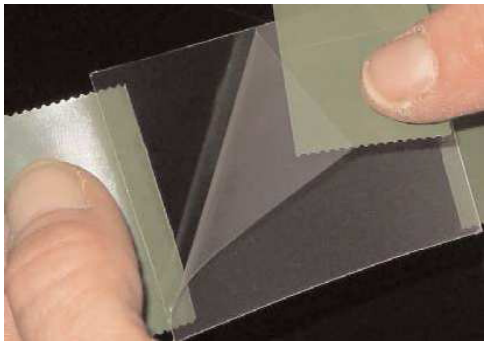

Figure 2. Removing easy release liner.

Step 2: Lamination (continued)

E. Align and roll down OCA/CEF on first substrate using a roller, squeezing out the air. Roll down pressure should be moderate. Be careful not to break your substrate.

F Remove the green tape tabs carefully without disturbing the release liner.

G. Remove the tight liner using green tape. Align and roll down the second substrate, squeezing the air out.

Alternatively, for flat substrates, a simple heat laminator can be used. Heat the laminator. Apply pressure and heat evenly across the sample. Use temperature above ambient for this process.

Once lamination is complete, visually inspect the finished piece for any bubbles or entrapped air around the display frame. This completes the process if no bubbles or entrapped air are observed.

For rigid-to-flexible lamination, the air gap around the display frame is less expected unless there is ink step/decoration on one or both of the substrates, in which case autoclave is required. Visually look for bubbles around the edge of ink line. If you observe signs of air gap or bubbles in the laminate, go to the next section.

For rigid-to-rigid lamination, some air entrapment is to be expected and autoclave is highly recommended. If you observe signs of air gap or bubbles in the laminate, go to the next section.

In most cases, vacuum lamination equipment minimizes and also eliminates the air bubble issue during lamination.

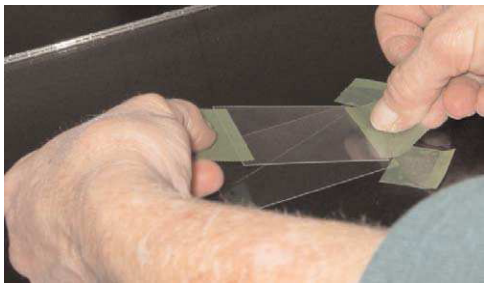

Figure 3. Aligning the OCA/CEF.

Figure 4. Rolling down the OCA/CEF.

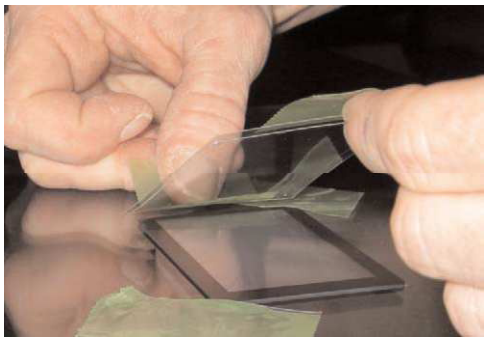

Figure 5. Aligning the 2nd substrate for lamination.

Figure 6. Completely laminated piece.

Step 3: Autoclave

The autoclave process works with heat and pressure to squeeze any remaining air out. The autoclave type must be dry. Typical autoclave conditions are outlined below.

Temperature: 30 – 60°C

Pressure: 70 – 100 PSI

Duration: 20 – 60 minutes

At this point the assembly process is complete for the part.

Step 4: Durability

This step is meant for customers who would like to determine the effect of long term device exposure to high temperature and high humidity. Most moisture absorbing substrates (e.g. PC and PMMA) fail this process because they outgas at high temperature and high humidity creating bubble in the assembly. Step 1 above is implemented to improve outgassing problem.

Here is a typical accelerated process condition.

Temperature: 65°C

Humidity: 90% R. H.

Duration: 12 – 72 hours

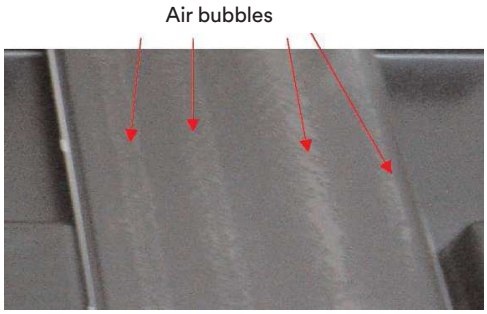

Figure 7. Sample before autoclave process.

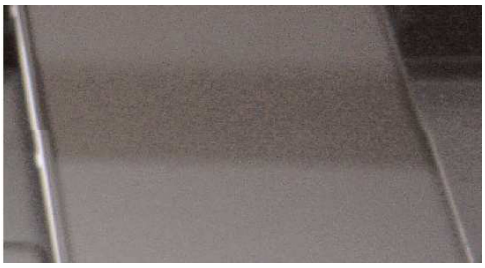

Figure 8. Sample after autoclave process.

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