



CMT MATERIALS, Inc.
 50 Eddy Street - Unit 18
 Attleboro, MA 02703
 TEL (508) 226 - 3901 FAX - 3902
 www.cmtmaterials.com
 email:info@cmtmaterials.com

Innovative Tooling Materials for Thermoforming

Syntactic Foam Plug Assists : Insert Evaluation
June 2000

One of the many questions asked about syntactic foam plugs is:

What is the best way to attach the foam plug to its supporting base structure?

Epoxy syntactic foams generally have poor tensile and shear strengths, making direct threading unadvisable. To overcome this problem, most thermoformers use some form of insert which is bonded and/or threaded and bonded into the plug. At CMT Materials, recent studies on two forms of inserts and three different foams showed the dramatically different pull-out strengths and failure modes which occur when subjecting the inserts to controlled pull-out loads.

For this study, three of CMT's syntactic foams from the *HYTAC* family of products were fitted with threaded inserts, (E-Z LOK #329-5 EXT 1/2-13 INT 5/16-18), or a scored aluminum insert designed by J&R Plastics of Acushnet, Massachusetts, (EXT 1/2 INT 1/4-20). The aluminum inserts were bonded into place using conventional 5-minute epoxy, the threaded inserts were not bonded. Figure One shows the test set-up on the 4206 Instron at the CMT facility. The foam samples were seated on the crosshead of the test fixture. Load was applied by pulling a threaded rod through a 2.0 inch diameter hole in the crosshead held by the lower grips. The ultimate load was recorded in pounds.

The table below gives a summary of the test results.

Syntactic Type	Description	Compressive Strength (psi)	Average Pull-Out Load (Pounds)	
			Threaded Insert	J&R Insert
<i>HYTAC-W</i>	Standard 350°F Epoxy Syntactic	6,200	576	572
<i>HYTAC-WT</i>	350°F Epoxy Syntactic w/Teflon®	7,900	760	639
<i>HYTAC-BIX</i>	350°F Thermoplastic Syntactic	6,300	1,062	615

Figure Two shows samples of the *HYTAC-W* following failure. Both inserts failed at essentially the same average load, but with much different types of failure. The threaded insert failed the foam catastrophically, while the aluminum insert simply pulled out in a failure of the adhesive. In this case, the foam strength was relatively the same as the adhesive. The advantage of the aluminum insert is that this plug could be easily repaired and put back into service quickly. The disadvantage is that the strength of the insert is totally dependent on the quality of the adhesive bond.

Tests of the higher strength *HYTAC-WT* showed similar results as shown in Figure Three. The aluminum insert again failed when the adhesive failed at approximately the same load as the previous test. Interestingly, the bond did not appear to suffer significantly due to the inclusion of Teflon® in the matrix. The threaded insert failed at a higher average load as expected, but again failed catastrophically.

Figure Four shows results of testing on *HYTAC-BIX*, the tough thermoplastic syntactic. Again the aluminum inserts failed at similar loads due to a failure of the adhesive. In this case the threaded insert failed at nearly double the load, but the failure was local to the threads only. The toughness of the thermoplastic prevents propagation of the failure into the entire structure. In this case it would be possible to simply drill and re-tap the plug, use a slightly larger insert, and have the plug back on the machine in a matter of minutes.



CMT MATERIALS, Inc.
50 Eddy Street - Unit 18
Attleboro, MA 02703
TEL (508) 226 - 3901 FAX - 3902
www.cmtmaterials.com
email: info@cmtmaterials.com

Innovative Tooling Materials for Thermoforming

Figure One: Test Set-up





CMT MATERIALS, Inc.
50 Eddy Street - Unit 18
Attleboro, MA 02703
TEL (508) 226 - 3901 FAX - 3902
www.cmtmaterials.com
email:info@cmtmaterials.com

Innovative Tooling Materials for Thermoforming



Figure Two: *HYTAC-W* Samples



Figure Three: *HYTAC-WT* Samples



CMT MATERIALS, Inc.
50 Eddy Street - Unit 18
Attleboro, MA 02703
TEL (508) 226 - 3901 FAX - 3902
www.cmtmaterials.com
email: info@cmtmaterials.com

Innovative Tooling Materials for Thermoforming



Figure Four: *HYTAC-BIX* Samples



CMT MATERIALS, Inc.
50 Eddy Street - Unit 18
Attleboro, MA 02703
TEL (508) 226 - 3901 FAX - 3902
www.cmtmaterials.com
email:info@cmtmaterials.com

Innovative Tooling Materials for Thermoforming

Recommendations

Several recommendations may be made from the study, preparation of the samples, and common practices used by toolmakers and thermoformers.

- ⇒ When bonding inserts, it is important to properly prepare the bond surfaces of both the insert and the foam. Both surfaces should be lightly abraded and wiped with a solvent such as alcohol or acetone prior to application of the adhesive. Make sure the surfaces are oil and dust free before proceeding.
- ⇒ The inserts should be installed so that they are flush with the surface of the plug. This will prevent pull-out of the insert due to overtightening if the insert is below the plug surface. Conversely, a flush insert prevents the plug from "wobbling" about the insert which could result in pull-out from cantilever loads applied to the top of the plug which resolve at the insert.
- ⇒ Excessive loads applied to threaded inserts tend to fail the entire plug due to the poor tensile and shear properties of epoxy syntactic foams.
- ⇒ Tougher thermoplastic syntactic foams fail locally around inserts at significantly higher load levels than standard epoxy syntactic foams.