

Composite Laminate Vacuum Bagging Procedure and Safety Protocol

Objective:

This document describes the required materials, personal protective equipment (PPE) and proper procedure for vacuum bagging of composite laminates. The following process is valid for composite laminates consisting of woven fibers (e.g. carbon fiber, Kevlar, fiber glass) impregnated with an epoxy resin system. **All vacuum bagging must be performed under the supervision of the ME 127 course instructor, ME 127 course TA, or Bray Laboratory staff.**

Materials:

Description	Acceptable Material
Fiber weave (Fiberglass, Kevlar/Carbon Hybrid, Carbon)	Fibreglast 543, 1065, 1069
Epoxy resin (1-hour cure)	Fibreglast 2000
Epoxy hardener (must correspond to resin)	Fibreglast 2060
Nylon bagging film	Fibreglast 1785
Release film	Fibreglast 1580
Nylon release peel ply	Fibreglast 582
Breather & bleeder material	Fibreglast 579
Sealant tape	Fibreglast 500
Quart mixing set (paper mixing cup and wooden stirrer)	Fibreglast 588
Serrated scissors	Fibreglast 1731
Plastic squeegee	Fibreglast 363
Vacuum (1/16 HP)	Fibreglast 888
Thru-bag vacuum connector	Fibreglast 910
Digital Scale	Fibreglast 1145
Oven/furnace	N/A
Acetone	Fibreglast 9
Shop rags	N/A

Safety:

Potential hazards during vacuum bagging include:

- Respiratory exposure to fumes from the epoxy curing reaction, acetone or other solvents, and fine fibers generated during the cutting of the reinforcement weave.
- Skin exposure to epoxy reagents, acetone or other solvents, and fine fibers generated during the cutting of the reinforcement weave. NOTE: Skin sensitivity to fine fibers may not immediately appear, but can develop over time.
- Flammability of solvents, such as acetone. Never use solvents near an open flame.

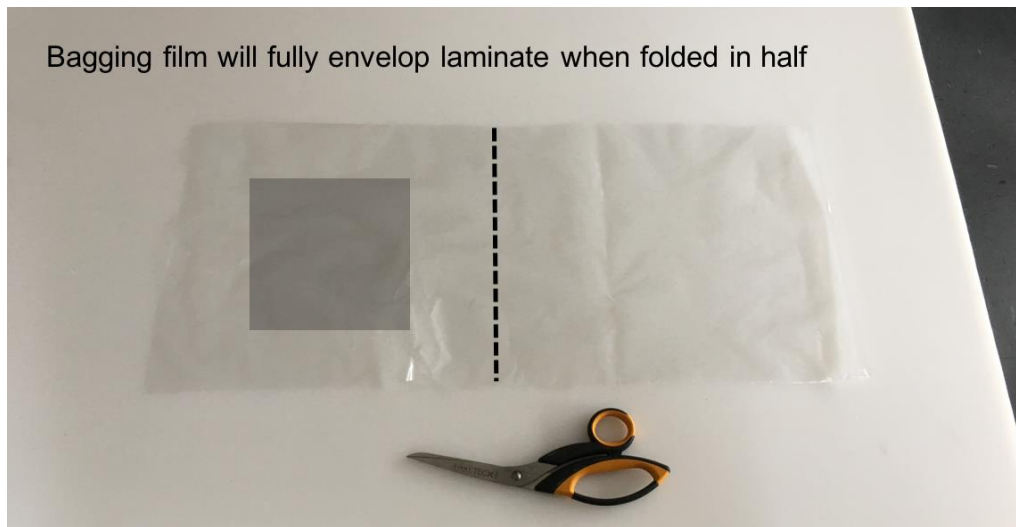
PPE to prevent exposure should include *at least* the following:

Description	Acceptable PPE
Safety glasses or goggles	Fibreglast 559
Dust mask or respirator	
Latex or nitrile gloves	Fibreglast 3, 10
Long sleeves, lab coat or Tyvek coverall	Fibreglast 540

Procedure:

The following preparation shall be performed in the Composites Lab, Bray 109. NOTE: Bray 109 shall have at maximum, 8 people working in the space at one time.

1. Cut Nylon bagging film to appropriate size so that when folded in half the film envelops the entire laminate.



Nylon bagging film should be large enough to create at least a 1-2" border around the laminate when folded over (e.g. if laminate is a 4"x4" square, bagging film should be cut to ~8"x16", so that when folded in half a 2" border remains on every side of the laminate).

2. Cut release film (x2), nylon release peel ply (x2), and breather & bleeder material (x2), so that each piece is slightly larger than the desired laminate size.
3. Lay the Nylon bagging film on a clean, flat surface. In the center of one-half of the bagging film, layer 1 piece of breather & bleeder material, followed by 1 piece of the nylon release peel ply, followed by 1 piece of the release film.



- Repeat the process using the remaining pieces on the other half of the bagging film (both sides should have the release film on the top of the material stack).



- The following operation should be performed while wearing a dust mask.** Cut the fiber weave to the desired size (as many layers as required for the lay-up). The fiber weaves are prone to shredding once cut; minimize handling and time between cutting and epoxy impregnation to prevent damage to the weave.

The following operations shall be performed under the fume hood in Bray 113. Use a flat tray to transport the bagging materials and fiber weave from Bray 109 to Bray 113. Take care not to distort or shred the weave while handling. **Make sure the fume hood is turned on and the sash is lowered halfway down to ensure proper circulation.**

- In a paper mixing cup, mix 100 parts epoxy resin with 27 parts epoxy hardener, by weight on a digital scale. Make sure to prepare enough epoxy to impregnate the entire laminate lay-up. Mix the resin and hardener using a wooden stirrer for at least 1 minute. Scrape the sides and bottom of the cup with the wooden stirrer to ensure proper mixing.
- Place the first layer of the composite laminate on one of the release film surfaces. Center the weave over the film.



8. Apply a small amount of epoxy to the top surface of the weave and spread over the entire weave using a plastic squeegee. Ensure the entire surface wets, then squeegee off any excess epoxy. Delicately, flip the weave over and repeat on the opposite surface.
9. Repeat Step 8 for each additional layer in the laminate (NOTE: after the first layer, only APPLY EPOXY TO THE TOP SURFACE). Orient the weave accordingly before placing on the previous layer.
10. Place the film stack on the opposite side of the bagging film face down on the laminate (i.e. the release film should be in contact with the laminate and the breather & bleeder material should be facing up).



11. On the free side of the bagging film, create a small hole to allow the thru-bag vacuum connector to connect through the bag (NOTE: the hose connector should be on the outside of the bag). Position the hole so that when the bag is folded in half, the hole will NOT be directly over any part of the laminate.



12. Fold the bagging film in half so the entire lay-up is enveloped by the material. Seal the three open sides of the bag using sealant tape (ensure a good seal by pressing firmly on the sealed edge all around the bag).



13. Connect the thru-bag vacuum connector to the vacuum hose and ensure a good seal.
14. Turn on the vacuum pump. Check the bag for leaks and repair as necessary with sealant tape. Allow the laminate to cure under vacuum for 18-24 hours.
15. Allow excess epoxy to harden in the paper cup in the fume hood and then dispose in the garbage.
16. Clean any epoxy from work surfaces using acetone. If working on a paper-covered surface, dispose of the paper in the garbage.
17. To remove the laminate after curing, turn off the vacuum pump, cut the bag open with scissors and peel away the release film. All bagging materials should be disposed in the garbage.