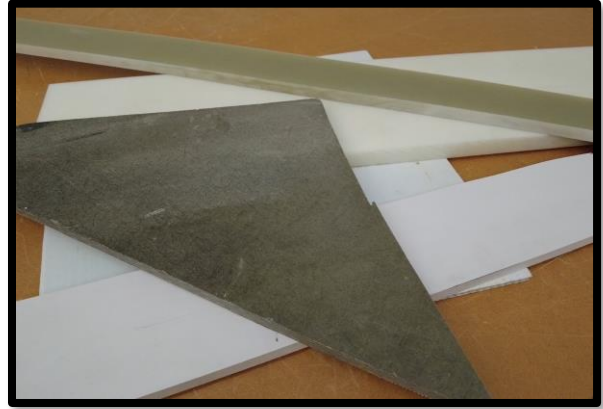


Composite Materials in Boat Building

Project Summary

In many restoration projects the question eventually comes up: what materials should replace the original wood components in the boat? Traditional marine plywood has been used for decades, but modern composite materials offer several advantages including reduced maintenance, resistance to rot, and weight savings.



During the ultra-lite dinghy, I began experimenting with a number of composite materials while building interior structures and cabinetry. Because the boat had been stripped down to essentially a bare hull, I had the opportunity to rethink how interior components could be constructed. The goal was to find materials that were lightweight, durable, resistant to moisture, and easy to work with using normal shop tools. This project focused on evaluating several composite materials that are commonly discussed in boat building: chloroplast, Coosa board, G10 fiberglass laminate, HDPE marine board (often sold under the brand name King Starboard), and PVC foam board. Each material has different properties and is suited for different tasks.



- New materials and brand names appear often in the industry.
- Names used to refer to materials or products may be tradenames or brand names.
- Materials should be identified by their material handling data in order to understand exactly what is the product



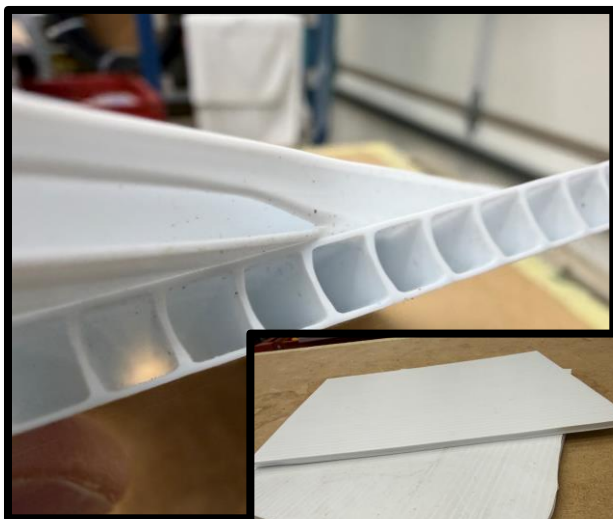
Composite Material Selection

When selecting materials for interior components on a cruising boat there are several important considerations. The material must tolerate moisture exposure without deteriorating. It should be lightweight so the boat is not unnecessarily burdened with additional weight. It must be workable using common shop tools, and ideally it should not require constant maintenance.(See Chart)

Cost is also an important factor. Some composite materials are extremely strong but prohibitively expensive for large interior projects. The ideal material balances durability, weight, cost, and workability.

The ideal composite material allows the amateur to use the product for many different projects, in many different situation, for many different purposes. It is true that some folks consider these products are “inter-changeable” in many situations, but the goal is a single product that allows you to ***do the most with what you have***. This saves time, money, effort, and allows the amateur to attain a high skill level through repitious use and familiarity.





Coroplast

One material that often appears in discussions of lightweight construction is chloroplast. This material is essentially corrugated plastic sheet that resembles cardboard made from plastic. It is extremely lightweight and inexpensive.

However, chloroplast is not suitable for structural cabinet construction. It lacks stiffness and strength. In boat work it can be useful for pattern making, templates, or as a disposable work surface when applying epoxy or fiberglass resin, but it is not a good candidate for structural panels or cabinetry.

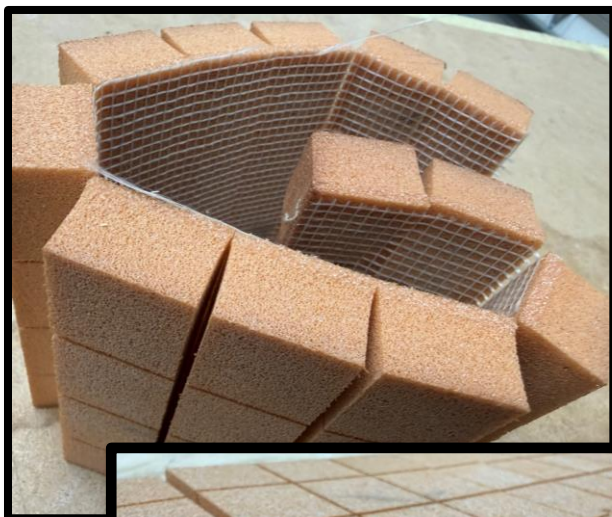


EPS Foam (Pink or Blue)

It's not uncommon to hear folks talking about using EPS (Expanded Polystyrene) foam. This is the pink or blue foam panels you can find at your local big box DIY store. While it is technical possible to epoxy this type of foam with fiberglass cloth, its structurally inferior and not recommended,

The real purpose of EPS is for insulation or pattern making ("Pink Foam Method").

It represents a rigid, often dimensionally accurate representation of other materials such as plywood and Coosa Board. Use EPS foam for bulkhead mock-ups, cabinet pattern making NOT for boat construction



Core Foams

Common trade names include:
Divinycell, Airex, Corecell
Klegecell, Herex, and Airex C

These are commonly used as lightweight structural cores in sandwich construction, where the foam sits between layers of fiberglass or other composite laminates to increase stiffness without adding a lot of weight. Instead of building a solid laminate. They come in a variety of types and can be cut to radius a surface or form curves.

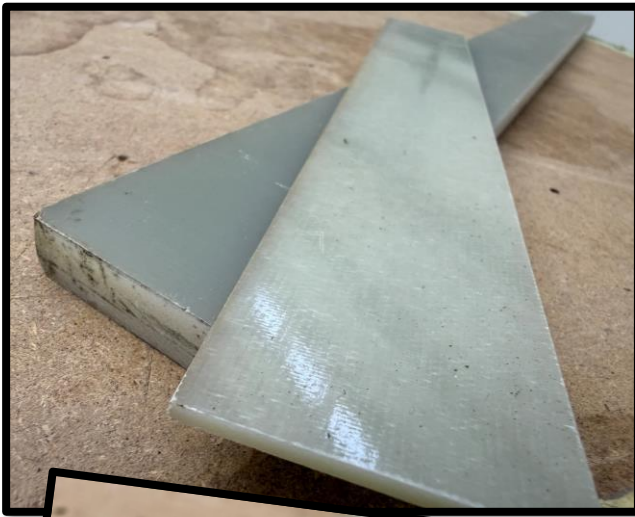
They can be prohibitively expensive for the amateur boat builder, and sometimes require special knowledge and extra work to laminate to fiberglass cloth and surfaces.

King Starboard (HDPE)

King StarBoard, which is a brand name for a marine-grade HDPE (high-density polyethylene). It's durable and rot-proof, but it's also heavy and expensive for the amateur

HDPE is also difficult to glue and epoxy. Because it has a slick surface, virtually all marine sealants and adhesives won't stick to it long term. It will also "cold form" and bend when placed under pressure, often making unsuitable for structural items like backing blocks and stanchion bases.





G10 Board

G-10 is a high-pressure fiberglass laminate made by stacking layers of woven fiberglass cloth that are impregnated with epoxy resin and then compressed under heat and pressure to create a very dense, extremely strong sheet material. The result is a board that is dimensionally stable, waterproof, and incredibly resistant to compression and wear. It is very expensive, very very heavy, and can be extremely difficult to work with woodworking tools due to its hardness and density. Its primary function in boat building is for compression loads or backing plates.

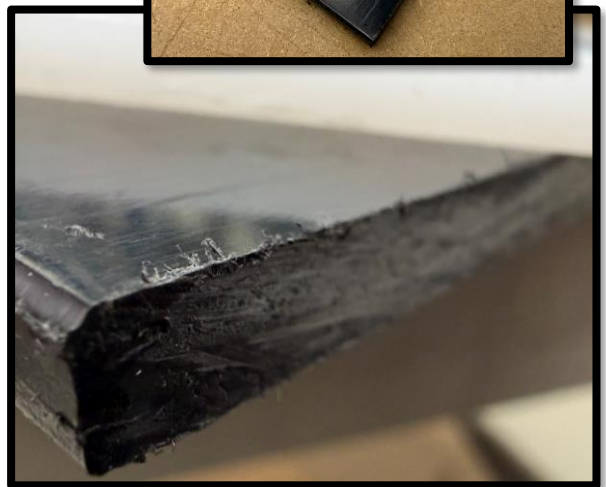


Plastics: Acrylic & Polyethylene

There are a variety of plastics and their variants that often have a place in non-structural boat building.

Costs depend on the product and properties. In most cases a patient and competent amateur can cut or mill plastics, and even thermo-mold them.

Plastics tend to be used for dash panels, windows, trim pieces, and even limited container construction. The important thing is to select the plastic with proper durability, and use it for the right project.



Plywood Variations

Old reliable. Cheap, readily available, easy to work with, it's uses are too numerous to name. But it has one disadvantage: it must be properly sealed with epoxy to avoid water intrusion and rot.

Be aware marine plywood is different from ordinary construction plywood because it is manufactured with **waterproof adhesives and higher-quality veneers**, and it typically contains **fewer internal voids**, which makes it stronger and more resistant to moisture intrusion.

As a budget solution when all else fails, I recommend quality hobby plywood with generous application of epoxy layers.



MDF (Medium-Density Fiberboard)

MDF is manufactured by breaking down wood fibers, mixing them with resin binders, and compressing the mixture into dense, uniform sheets. The material machines very easily and produces extremely smooth surfaces. It is relatively heavy.

It has been used successfully by amateurs to build cabins and above waterline structures. However, it requires extra work to seal the edges and may not be appropriate in high load areas or radius applications. I discourage its use for the typical amateur due to extra work and weight.





PVC Foam Board vs. Craft Poster Board

Extruded PVC foam board is an entirely different material. It is a rigid plastic panel and should not be confused with lightweight craft materials.



PVC Foam Board

PVC (polyvinyl chloride) foam board is a dense, rigid sheet plastic that can be used for building boat cabinets, seat backs, and non-structural items.

Common trade names include: Celtec, Sintra, Komatex, Forex, and Trovicel. It can be fire retardant and chemical resistant depending on brand.

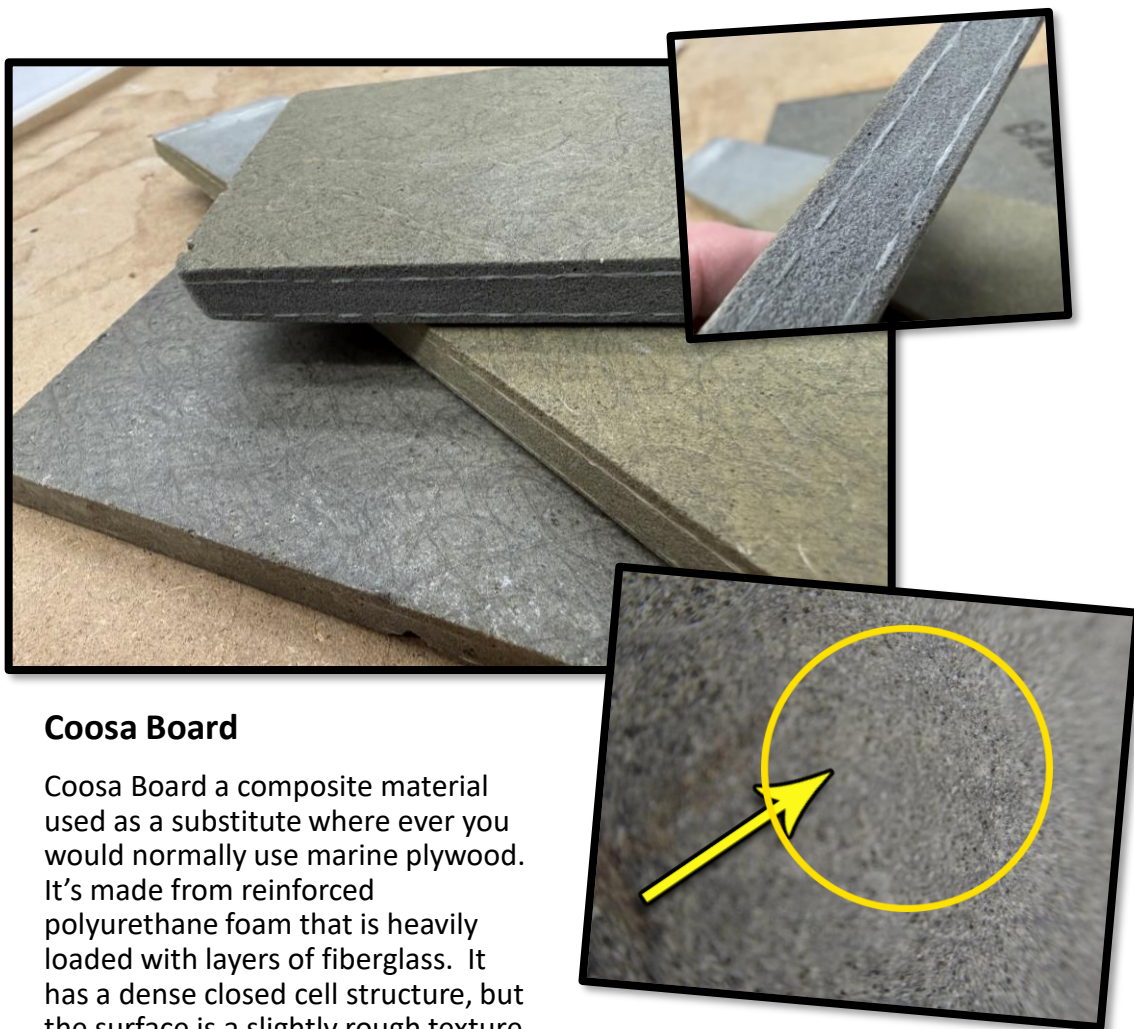


This material is not the same as extruded PVC trim available in DIY big box stores. Unlike foam cores, extruded PVC foam board contains microscopic air cells throughout the material, making it lightweight while still reasonably rigid. It can be expoxied, as long as the smooth foam board surface is sanded to give texture so the epoxy can grip. Interior fiberglass tabbing is recommended for extra joint strength. It can also be painted to present a uniform finish.

In cabinet making, PVC foam board can be a light weight, low maintenance, water proof alternative to heavier plywood, and a cheaper alternative to Coosa Board.

The amateur boat builder needs to be aware that PVC foam board is not the same as "crat foam core poster board." PVC foam board is not appropriate for structural building such as hardtops, cabins, or decking. It is also not appropriate as a backing plate or stanchion base because with will deform (cold mold) under pressure and will bend and ultimately break with enough force applied.





Coosa Board

Coosa Board is a composite material used as a substitute wherever you would normally use marine plywood. It's made from reinforced polyurethane foam that is heavily loaded with layers of fiberglass. It has a dense closed cell structure, but the surface is a slightly rough texture.

Advantages of Coosa include: 30-40% lighter than marine plywood, completely waterproof, rot-proof, and impervious to insects. It doesn't need to be hot coated with epoxy like traditional plywood, in fact it can be painted with no fiberglass if necessary. Boat builders commonly use Coosa Board in places where plywood was traditionally used, such as transoms, stringers, bulkheads, deck cores, seat bases, and structural backing panels. Its biggest disadvantage is that it's expensive relative to plywood, often \$300+/per eight by four sheet. It comes in different densities, but I usually recommend Blue Water 26 for most amateur projects.

Coosa Board can be cut and worked using common wood working tools. It can be sculpted using a grinder/sander to create unusual curves that an amateur otherwise might not be able to accomplish. Coosa Board remains my go recommendation for amateur boat builders because of its versatility, compatibility with epoxy fiberglass, long term durability and strength, and over-all idiot proof ease of use.



Cost Benefit Analysis

Many people will argue that composite materials (especially Coosa Board) are too expensive for the amateur boat builder. I argue it's too expensive not to. Expense is not just a measure of money, but of labor, time, *and* money. In the case of Coosa Board, if you compare the up-front cost of the material and along with its long term benefits (weight, durability, ease of epoxy fiberglass, plus waterproof nature) the true value of the material outweighs a traditional materials like plywood. In many locales, Coosa Board is within 20% the cost of actual marine plywood. It may cost less to buy a sheet of plywood, but plywood weighs 30-40%; it requires additional labor steps, extra expense when fiber glassing or epoxy coating, extra waiting time for curing and re-glassing—and still it will still ultimately fail over time. Coosa Board absorbs less than .1% of liquids so it requires substantially less epoxy than plywood. A single bit of damage to a plywood epoxy coated surfaces negates its waterproof properties leading immediately to rot and eventual delamination. On the contrary, damage to Coosa Board will produce no rot and no matter what happens Coosa Board remains waterproof.

How to save Money Purchasing

To reduce the cost when buying composite materials I recommend amateurs find a local plastics distributor or sign making shop (where they often use these materials). By purchasing the materials from a distributor instead of a marine chandlery or retail vendor you get a better product at a cheaper price.

Always buy in full sheets, and avoid over-buying composite material. Buy just enough material and use it only for marine construction/projects. Remember unlike plywood, Coosa board can be re-laminated (staple and glue method) taking small pieces and cut-offs and reassembling them for re-used in other projects-- providing for little to no waste material.



Lessons Learned

- ❖ Composite materials offer many advantages over traditional plywood in boat restoration projects. However, each material has a specific role. Some composites are ideal for structural components, while others are better suited for lightweight interior structures.
- ❖ Coosa board is the preferred material for structural repairs where strength and durability are critical. It has significant advantages to plywood, and while the up-front cost is greater, these advantages are the true value of this material.
- ❖ For interior cabinetry and non-structural panels, PVC foam board provided an excellent balance of cost, weight, durability, and ease of fabrication. ***PVC foam board is not to be used for structural projects.***
- ❖ Understanding the strengths and limitations of each composite material allows the amateur builder to select the right product for each application rather than relying on a single material for everything.



Composite Material In Boat Building Comparison Chart

	Ease of Use	Epoxy Compatible	Adhesives	Weight	Waterproof	Pattern Making	Structural	Project Versatility	Cost
CoroPlast	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★
EPS (Pink & Blue)	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★
Core Foams	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
HDPE (King Starboard)	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
G10 fiberglass board	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
Plywood Variations	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
MDF	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
Plastics (Acrylic & Poly)	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
PVC Foam Board (Celtec)	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
Coosa Board	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★

