The Unresolved Afterlife *of* Composite-Built Boats

Demands for greater accountability for waste are driving innovations at the beginning and the end of manufacturing. These ideas may someday provide economical solutions to disposing of the growing number of aging fiberglass boats. But there's some work to do.

AARON PORTER

The cost of recycling most composite boats is more than their raw materials are worth. But thanks to recent advances in resin chemistry and recycling technology, by recycling high-value carbon fiber—such as the production scraps shown here—new markets for products made of recycled materials could someday open a waste stream for FRP boats.

by Melissa Wood

Even the most expensive, cutting-edge yachts have a hard time finding a purpose once they've outlived their primary one. *USA-65* was one of Seattle-based One World Challenge's two boats built for the 2003 *America*'s Cup. After the race, which New Zealand won, she was sold to Spanish team Desafío Español. She was then trialed for two years and abandoned at the Valencia Yacht Club, apparently forgotten until 2014, when the mussel-encrusted keel dropped off her hull, setting off a chain reaction that broke her mast and rolled her over at the dock.

Another U.S. yacht, Team Oracle's AC-72 trimaran, dramatically won the 34th *America*'s Cup in 2013, and now sits idle in a warehouse in Oakland, California. Her older teammate, the *USA-71* IACC-class monohull, was launched in 2002, and never raced in actual Cup competition but was used for trials and training. After outliving her purpose, she was displayed in the lagoon in front of Oracle's headquarters in Redwood City, California, for six years as a kind of corporate symbol.

Then *USA-71* made the news in October 2013, when her hull was donated to the science of composite recycling. The 7,000 lbs (31,175 kg) of carbon fiber from the boat's 84′ x 12′ (25.2m x 3.8m) hull were chopped into 4′ (122cm) sections. Those pieces and its 105′ (32m) mast were sent to MIT-RCF (now called Carbon Conversions) in South Carolina to be recycled. Other parts were sent to the University of Nottingham, in England, as part of a Boeing-funded research program that looks at second-life uses for carbon fiber, which is the primary material in its 787 Dreamliner jet airplanes.

Oracle bought back the recycled carbon fiber and sent it to New Zealand to be used in molds to build AC-45s. The cost to recycle the material was a few dollars per pound. The full recycling effort cost between $15,000 and $18,000, according to Chris Sitzenstock, the logistics manager for Oracle USA. "It wasn't crazy numbers, and then we bought the material back at a few dollars a pound, so buying the material back was more cost-effective than buying virgin carbon fiber."

He pointed out that the recycling really worked only because Oracle paid for it. "You really have to be big and wealthy. There's almost no [other] way." That's because the amount of waste to be recycled is massive, and there's little market for recycled carbon fiber. For the market that exists, other low-hanging fruit, like production waste from Boeing that's never been cured, is easier to recycle than a used *America*'s Cup hull.

If you take a broader look, the challenge of building a market for recycled products is not confined to composites. Sitzenstock: "I was the guy who cleaned up Pier 80 after the San Francisco *America*'s Cup. We had the time and we wanted to do it right,"

COURTESY TEAM ORACLE

After Team Oracle's USA-71 *hull was chopped up* ***(above),*** *its carbon fiber was recycled into tooling for next-generation AC-45s.*

by separating steel and aluminum. But the race took place right around the time the steel market went bad. Lines at scrap yards that once took 45 minutes were suddenly empty. At a certain point, they realized that the cost in man-hours to collect and separate the scrap was more than it was worth. "It was like throwing it away. If we can't recycle pure steel rebar, what chance do we have?" he said. "Good luck, carbon. Your average Bayliner? That's decades away."

However, despite the challenges, Sitzenstock believes that efforts like recycling *USA-71* are not in vain. They serve as viable proof of concept for future projects. As he pointed out, "We did it, and there were articles about it. This actually happened. You can do it too, if you want."

Grind It Up

For FRP boats there *is* no afterlife, and it's a problem. In 2010, for example, when Florida's Fish and Wildlife Conservation Commission began a statewide database to keep track of derelict vessels left in public waters, it estimated a cost of just under $3.2 million to remove the abandoned vessels. Owners there who abandon their boats can be charged with a third-degree felony, and face five years in prison and a $5,000 fine, plus the cost of repaying the state for the boat's disposal. Even more troubling for the boatbuilding industry is legislation proposed earlier this year that would make it illegal to anchor overnight in parts of the ICW. It was spurred in part by property owners who were tired of having derelict boats anchored in their views. (For more on efforts to clean up abandoned or unwanted boats, see "Boat Breaker," *Professional BoatBuilder* No. 160.)

Rich O'Meara is the owner and president of Core Composites, in Bristol, Rhode Island, a division of ROM Development Corporation. With composites expert Richard Downs-Honey, he co-presented the seminar "What Do You Mean: Green?" at the International BoatBuilders' Exhibition & Conference (IBEX) in 2013. He thinks the solution is pretty simple. Legislation should prohibit full-size hulls from going into landfills.

O'Meara: "As soon as you do that, everything starts to work. Everything else will follow, because you've forced them to reduce the waste size, which means you've pulled all the metal off, which is already recyclable; you leave a boat hull out there, the metal's gone in two weeks. You'll never know what happened, but there's a whole black market. It's got scrap value. And then you've got everything else that's inside a boat, like the wood. Some of it's teak, which is around $7 a board foot. You leave a pile of teak lying around, it's going to be recycled into another boat, guaranteed. All you've got to do to make it happen is reduce the size of the waste.

"I mean, if we end up pulling the boat apart, we're going to segregate the stuff. That's the beginning. That's the first thing you legislate. Through grants you help that recycling center buy the correct piece of equipment to decompose or reduce the waste. Then the government knows where all these hazardous things are getting taken apart. They know what's going on in there because they can send OSHA [Occupational Safety and Health Administration] to look at it. They can send the EPA [Environmental Protection Agency] in to look at it.

"And then the fiberglass is real easy," O'Meara continued. "You put it through a chipper. It costs nothing. For a hundred grand you could have a chipper that could chip every boat in Rhode Island. And you've reduced the waste, and you throw it in a landfill. Honestly, that's it. We could finish and go eat lunch, because that to me is where it is in 2016."

If grant money were available, it could be used to help develop composite recycling technology and markets for the new products incorporating those recycled materials. And if that doesn't happen? Those ground-up pieces can simply wait. He predicts that 100 years from now, "when the burn ends" (meaning, when we stop taking vast volumes of fossil fuels out of the ground), people will be going through landfills to collect those pieces, since they'll contain valuable energy. "My point is that embodied energy of all the plastic things in the world will be sitting there, and we do know how to take them apart now."

Burn It

When they come together as a composite material, fiberglass and resin are virtually indestructible. Chop it up though, and the pieces have little use. O'Meara experimented by dumping a mix of old FRP into concrete to make parking lot buffers, but "even at a low, low level, it just weakened it, and that's because the fiberglass wasn't really able to reinforce the concrete. The resin was inhibiting a good bond to the concrete."

So, to reuse the components that make up an FRP hull, you have to chemically separate the resin and the fiber. But fiberglass is made of sand. The price of fiberglass has actually gone down during O'Meara's 40-year composites career because of improved technology. Resin is worth more, but the recycling process turns good resin into a lower-grade product. O'Meara said of the numbers: "The fiber's worth 50 cents a pound new. I can't recycle it for less than $2. The resin I'm pulling out of it, which is 40 or 50% of the weight, is worth $1.10 new, and [lower-grade] phenol or resin resorcinol, which is used to make plywood, sells for about 80 cents."

But what if you couldn't put those composite pieces in a landfill and wait? What's left if you can't store the waste or recycle it?

When Dennis Nixon became director of the University of Rhode Island's Sea Grant program three years ago, he made a pledge to work more closely with waterfront businesses, which include marina owners who often have to figure out what to do with old boats abandoned on their property.

He agrees with O'Meara that the first step in the process is finding some feasible way for boat hulls to be ground down, and could also envision a boat-grinding business operating like a mobile paper-shredding business that takes away shredded paper for a fee. To see what that would entail, Nixon proposed a test case sponsored by Sea Grant. "A local boatyard had volunteered the use of their facility, and we were going to pay yard workers an hourly rate to get a sense of how long and how difficult it was to tear a boat apart."

The project stalled after a reviewer for the grant agency pointed out that they'd end up with "a great big pile of fiberglass and nowhere to put it." But Nixon hasn't let it drop. A year later he and Evan Ridley, a graduate student at the University of Rhode Island who is working full time on this issue, are excited about what they think could be an economical solution. They are trying to emulate the European wind-power industry, which has been sending 100% of its fiberglass waste to the German cement factory Holcim. Germany doesn't allow for disposal of any type of composite waste in its landfills. Instead, the waste is burned as fuel in a kiln for cement production, and the ash from the kiln can be mixed into the concrete without degrading its material properties.

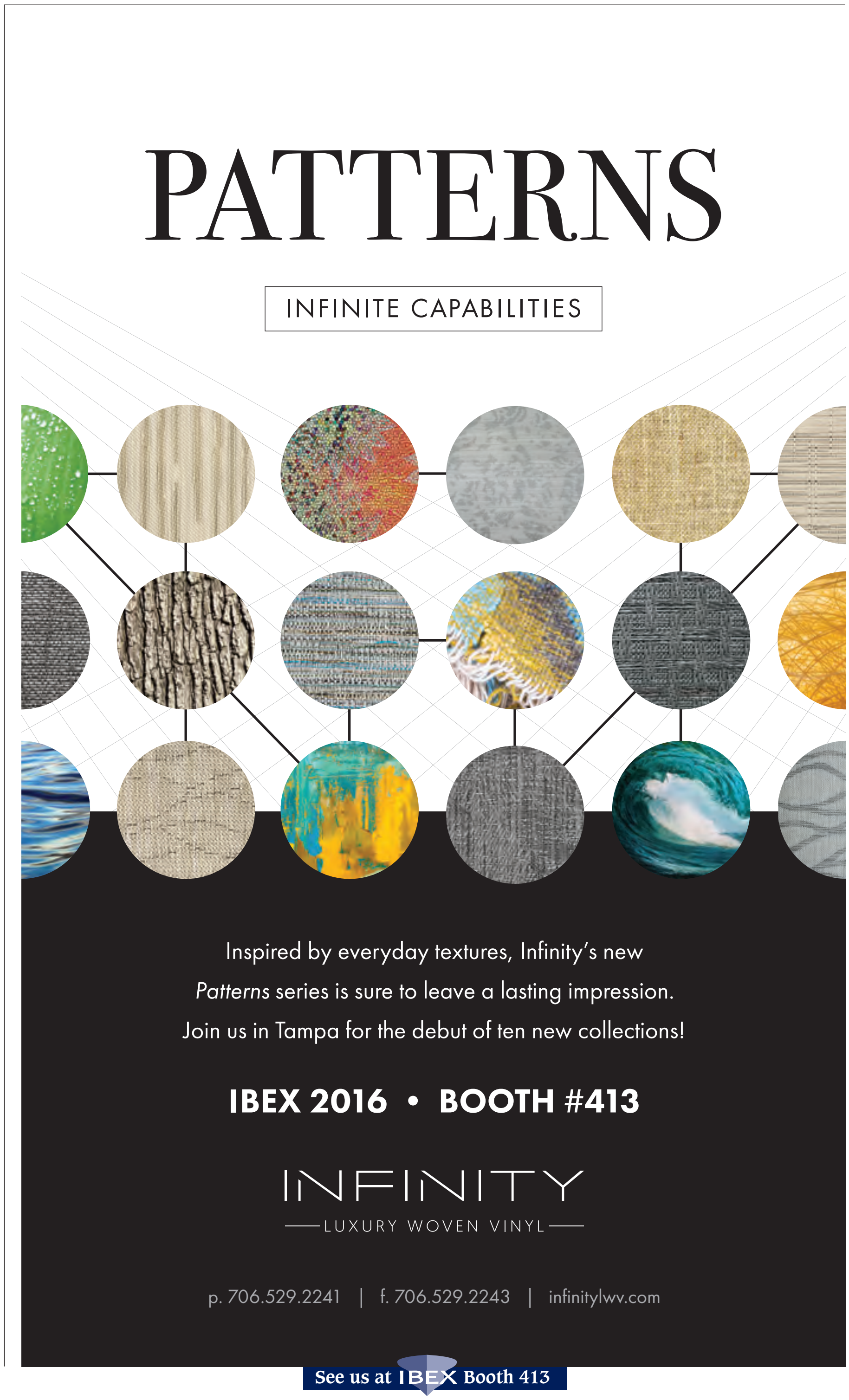
Nixon: "I think the key thing here that's different is in the past we've taken shredded fiberglass and mixed it into an existing concrete," which degrades that mixture. "Burning the fiberglass—what's left of the burned fiberglass has the appropriate chemicals to mix into the aggregate [cement]," Nixon said. "So you're treating the fiberglass through the process of burning it, and then what's left has the right mix of the chemical elements in it to be easily incorporated into concrete. When it's burned in a kiln it's turned into a gas. It is used to power the technology that's doing the burning, so it's a self-sustaining system in a way.

"Any of the other uses were going to require a subsidy of some kind," Nixon continued. "If we were going to use it in molded plastic furniture, it was clear you'd have to be charging a lot more and the product would be a lot heavier, because once you have the fiberglass chopped up it doesn't have the strength it once had. This is a method that takes what is inherently a pretty dirty product because of the fact that any fiberglass has gelcoat, paint, bottom paint. It also possibly has a core, so it's not a pure product, therefore we can never guarantee the purity of a feedstock into a fancy finished product. This is a way that we can use all the waste. Even after incineration."

"Right now there's a lot that's technically feasible in terms of recycling fiberglass, but none of those things are economically feasible, because the market isn't there," said Ridley. "This is the first thing I've seen in my research where it makes economic sense for people to buy into a system."

Now that they've identified a potential solution, Ridley is planning a trip to Europe to learn more about Holcim, and then to approach contacts in the North American concrete industry to see if they're interested in the burning method. Then Ridley and Nixon can go back to the original challenge of finding ways to break down the boats.

"If we can develop centers where fiberglass is broken down to size, then we can start shipping railcars full of it wherever these cement kilns are located," said Nixon. "We're pretty



pumped about it right now. We're hoping to get Evan over to Europe in the next few months and learn how it works over there. We're not doing this to make a fortune. We're in this to solve a problem. This is potentially a new alternative that has not been considered in the U.S. We're going to try to hunt this one down and get some answers so we can begin to deal with our own very significant backlog of boats."

Recycle It

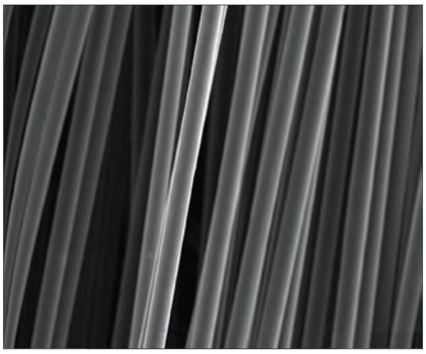
Burning composites in cement kilns is one solution. But let's not overlook O'Meara's point about the energy contained in those forgotten scraps of FRP at the landfill. If you burn it, you're also burning off the resin, which means you lose the energy that could be saved for future generations. And that means it's time to take another look at composites recycling.

Ron Allred is a rocket scientist. He has a doctorate from MIT (Massachusetts Institute of Technology) in materials, with an emphasis on polymers, and previously was part of the materials research group at Sandia National Labs. He's also affiliated with Gitan Technologies, where a colleague developed a tire-recycling technology. "I decided that if they could do that on rubber, then I could probably apply it to any kind of polymer," he recalled. In 1990, he founded Adherent Technologies, in Albuquerque, New Mexico, where he's been working to develop and refine that process in a pilot project.

The chemical process takes place in a sealed tank reactor—a fairly standard chemical-engineering process, according to Allred. The composites, which must be shredded down to 1″ (25mm) or smaller, are combined with a liquid heat transfer and catalyst. "That's processed under low heat and pressure, so the polymer and the composite chemically break down into a low-molecular-weight hydrocarbon mixture. The hydrocarbons are essentially dissolved in the liquid heat transfer fluid. Then that frees up the fibers. At the end of the reaction the mixture of fibers and liquid is dumped into a centrifuge. There, the liquid is separated from the fibers. After the heat transfer fluid is removed, the fibers are washed and dried and they're ready for reuse. They're processed into a nonwoven mat that can be used to make new components."

Such a process doesn't destroy the resin but rather breaks it apart, so the fibers can be extracted from it. "It's just chemistry," said O'Meara: "Think of a washing machine. So you put water in with soap. The soap breaks down the dirt, and the centrifuge spins, everything gets caught in the filter, all the water goes down the drain."

I met with O'Meara in his office. During this part of the conversation, he showed me a golf-ball holder made of recycled carbon fiber. "I'm showing you the evolution of this whole thing over here. That's what comes out of the washing machine. We emulsified it; the solvent is totally



COURTESY ADHERENT TECHNOLOGIES

A microscopic view shows reclaimed carbon fibers after 99.78% of the resin from their previous application has been washed off in a chemical process developed by Adherent Technologies. The reclaimed fibers are ready to be reused in a new composite.

recyclable, and I mean all of it. It's basically like putting a pot of water on. You heat it up, you distill it, and you reuse it in the process, so it's a completely closed loop. No pollution. You can start with a gallon [3.8 l] of acetone or MEK here, and you're going to get 99% of the gallon back after you've cleaned the resin off of the fiber. Pretty cool.

"And if you sent [Allred] a couple hundred pounds of scrap he'd send you back a couple hundred pounds of recycled material separated. You'd have a bunch of fiber in one bag, and you'd have a bucket of resin."

Compared to other types of composite recycling, including pyrolysis (explained in "Recycling Dead Boats," by Eric Sponberg, PBB No. 60), Allred's method using a low-temperature liquid process is the most environmentally friendly, according to O'Meara. Allred explained: "First of all, pyrolysis has an enormous amount of air-pollution emissions that have to be dealt with. We don't have any of that, and that burning process really harms the fibers. It degrades the outer layers of the fiber's surface, and for carbon fibers the surface structure really determines their strength. Pyrolysis degrades the fiber's strength by 30% or more."

After 25 years of working on a government-supported pilot program, Allred is getting ready to scale up by breaking ground this summer for a plant in Wichita, Kansas. "That would be to support the aviation industry there. And we have an agreement to take all their scrap. Spirit is the manufacturer of the forward fuselage of the 787 airliner. Our company plans are to follow the Wichita plant with one in Seattle, and one in South Carolina—that's where all the Boeing manufacturing is being done." Allred said the plant will take about six to nine months to get online, and they plan to recycle 500 tons of carbon fiber every year. That business model makes sense, because the volume and value of the carbon fiber scraps from those plants can be converted into a lower-value carbon fiber. The recycling equation works if carbon fiber costs $9 a pound and just $2–$3 per pound to recycle.

Who's going to buy it? Allred said

he's looking into different markets, including recycling aircraft parts right back into the aircraft. Because the fiber is shorter chopped strand, it can't be used for structural parts, but it can be put into lightweight bulkheads, seatbacks, and storage bins. He's also looking at sporting goods, and the automotive and marine industries.

And he's not the only one investigating these markets. A push toward improved fuel efficiency has seen the rise of lightweight carbon fiber in automobile and airplane manufacturing. In July 2016, the trade association Composite UK released the report "Composite Recycling: Where Are We Now?" Its authors estimated that the global market for composite products will reach $95 billion by 2020, an increase of 40% from 2014. "Inevitably this results in more waste. End-of-life waste for CFRP is still small, though production waste can be 30 to 50% of production volumes where prepreg processes are used." Along with fuel efficiency has come greater accountability for the next life of materials, either through legislation, such as automobile-recycling requirements, or the recycling commitments of major companies wanting to maintain a positive public image; for example, in 2014 Boeing announced its goal to stop sending solid waste to landfills by 2017.

Recycling in the U.S. received a boost in 2015 when the Port of Port Angeles, Washington, was awarded a $2 million grant from the U.S. Department of Commerce to turn an existing facility into the new 25,000-sq-ft (2,323m^2) Composite Recycling Technology Center. Its mission is "to lead and grow a composite recycling industry that fully diverts Washington State's carbon fiber scrap into value-added products." The nonprofit facility's operators aim to support 1.4 million lbs (635,029 kg) in its fifth year of operation.

Consequently, the increase in recycled carbon fiber may also provide another source of material for boatbuilders. However, to find traction in the marketplace, products made from recycled carbon fiber must have some standards, according to Ginger Gardiner, senior editor of *CompositesWorld* magazine. That could open up opportunities for boatbuilders to access low-grade carbon fiber as a building material. "Automotive and aerospace, they need to push [composite recyclers] to get together and have standards; you've got a standard data sheet, and you know what you're getting. They've got a lot of inventory—that's the issue they face in the industry. So if the marine industry could use it in decks and in console panels—you might be able to make it into a really strong, lightweight transom—it's going to help everybody. We need to get the circle spinning.

"Nonwoven mat is excellent in marine tooling, but BMW has now shown you can make parts. Airbus is using it to make parts. So yeah, the technology is moving really quickly."

Gardiner, who puts together the Future Materials exhibit at IBEX, along

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with *Professional BoatBuilder*, said she recently saw a presentation at the University of California, San Diego, where a company had chopped up waste prepreg, thrown it into a compression mold, and put it into snowboards and skateboards. Gardiner described the result as a "funky 3D solid surface" carbon twill with "gorgeous aesthetics" that she could easily see replicated in compression-mold hatch covers. "You can get some cheap presses; you don't have to have a fancy press," said Gardiner. Maybe they won't end up revolutionizing boatbuilding, but at least they'll provide another option, which Gardiner said is a goal of the Future Materials exhibit. Her husband, Jim Gardiner, is a boatbuilder, so she knows it's helpful to have as many tools as possible to deal with the challenges of any given day in the boatshop.

"He never knows when someone's going to walk through the door and ask for something insane," she said. "So the goal is to give them as many resources as possible."

Building up the market for recycled materials could eventually impact the afterlife FRP fleet, too. While recycling starts with high-value carbon fiber, once the market for recycled carbon fiber starts to generate demand, O'Meara predicts it may help facilitate recycling other composite materials as well. "Once those factories exist and they're looking for more things to do with those factories, you'll start to put Kevlar through, and then you'll start to put fiberglass through, I think."

Thermoplastics

Another approach to determining the afterlives of composite boats is to change how they're built. Almost all boats are now constructed with thermoset resins such as epoxy, vinylester, and polyester. Once cured, these resins can be separated from the fibers only by a chemical process. In contrast, thermoplastic resins can be melted down and shaped into something new. The recent development of thermoplastics for composites has been "enabled because resin chemistry has improved so much," said Gardiner. "The aerospace industry has embraced it pretty solidly."

In Oceanside, California, the company Bounce Composites uses thermoplastic polypropylene to make stand-up paddleboards. The boards are "built backward," said founder James Hedgecock, meaning that they bladder-form the outside of the boards first. "So it's a single-piece composite-construction hollow part, and then we put it in a fixture and we fill it with Coast Guard buoy foam," he explained. That process produces durable fiberglass boards and also allows for greener manufacturing that abides by California's strict environmental laws.

"For example, we don't shape a blank, so we don't have all the dust and waste and foam and by-products


COURTESY BOUNCE COMPOSITES

Bounce Composites builds stand-up paddleboards in Oceanside, California, with thermoplastic resin, which is easier to recycle than traditional thermosets.

of that. We don't sand fiberglass, and we don't paint, so there's no paint booth that has to be permitted," said Hedgecock. He also has plans for recycling the scrap that gets thrown away when the board templates are cut out: he has started making Ping-Pong paddles out of it.

To see thermoplastics in action today in the marine world, you have to look to competitive racing boats (which is similar to the carbon fiber recycling of Team Oracle's *US-71*). In November 2015 the hull and deck of a Mini 6.50 was infused for team Lalou Multi in Bordeaux, France. The deck and hull were the first carbon fiber components of their size to be infused with a recyclable acrylic resin called Elium. Its maker, the French company Arkema, formulated the thermoplastic to be low viscosity so it is a liquid at ambient temperatures, allowing it to be compatible with closed-molding, vacuum-infusion, and resin transfer molding (RTM)—production techniques that boatbuilders are already familiar with.

Dana Swan, a scientist with the company's glass group at its U.S. base in King of Prussia, Pennsylvania, said R&D for Elium began about five years ago, and the resin had its commercial debut in 2013. To build the Mini 6.50 *Arkema 3* required another 18 months of R&D. Construction was completed in February 2016, and the boat debuted in March at the JEC show in Paris. It was launched in June at Port-Médoc in Gironde, France. After her trials and testing, skipper Quentin Vlamynck plans to race her in the 2017 Mini Transat.

"Although the processing was similar to traditional thermoset processing, it is a different reaction chemistry, and it's a different matrix, so we had to make sure the fiber was compatible with Elium and additional changes in the formulation to deal with the larger-part infusion," said Swan. "For a straight mechanical property we're actually very similar to your higher-end epoxy chemistry, so much higher than your polyester-type chemistry. If you look at straight impact, we actually perform better. There's less crack propagation

COURTESY ARKEMA (BOTH)

Arkema's recyclable thermoplastic resin Elium was used to infuse the carbon fiber hull ***(above)*** *and deck of a Mini Transat 6.50* ***(right),*** *launched earlier this year in Gironde, France.*

on Elium parts compared to epoxy or polyester parts, so when there's a hit, there's less overall damage to the part."

The bulkheads and deck were glued to the hull with methacrylate adhesives from Bostik, a company Arkema acquired in May 2015. "Now they're under the Arkema umbrella, so we have the benefit of not only being able to have the Elium resin chemistry, we also have the [polymer] initiator Luperox chemistry in-house and the adhesive chemistry in-house. Because we have all three components under the Arkema umbrella, that really gives us the unique opportunity to be able to tailor the reaction and tailor the process," said Swan.

"The case of Lalou is special because Lalou produces racing boats with carbon fiber. But of course we also deliver up solutions for glass fiber for more-traditional sailing boats," said Guillaume Cledat, global business manager for Elium. He said they've started infusing smaller parts in France as well as a 25m (82′) wind turbine blade this summer. "What we saw basically is that surface smoothness of the parts made of Elium and glass fiber is impressive. The surface is very smooth and glossy, and much nicer than what a normal yacht gets with a thermoset resin like polyester or vinylester resin."

Elium was introduced to American boatbuilders as part of last year's Future Materials exhibit at IBEX. At the time, Gardiner pointed to it as one of the most exciting new products. "The properties are amazing," she said. "It's close to epoxy in modulus, but you're getting two times the toughness you would in a polyester resin, and it's running about the same price as epoxy."

Now that Elium has been developed, introduced, and prototyped in a marine application, Arkema's next step is marketing, which is no small task either; boatbuilders don't tend to jump on new technology until it has been proven necessary. In that case, Swan said it may have a more immediate appeal to European boatbuilders. "One of the interesting things about Elium is it's styrene free, where a lot of your thermoset chemistries are not, and right now, because of the labeling issue in Europe, any boatbuilders that are using material that contains styrene are facing additional challenges. Elium gives them an opportunity to still process the RTM- or vacuum-infusion-type parts but with styrene-free resin. The labeling is not in the U.S. yet, so for right now we're waiting to see where we're going to go, but we're starting to approach different marine customers to see if there's interest or not."

Conclusion

Clearly there's more than one option for an old boat's next life, but each possible scenario has drawbacks. You could grind boats up and store the waste until markets and technologies make it profitable to extract the energy held in the material. But for some, that's too long to wait. You could send those ground-up FRP composites to cement factories to fuel the kilns and then mix the ash into the aggregate, but that process burns off the energy entrained in the resin.

A more environmentally benign choice would be to build up the market for recycled composites so it could someday accommodate FRP. But the high volume of FRP waste and the low prices of competing materials mean that will probably take some time. An even more ambitious option is to begin building with materials that are easier to recycle, such as thermoplastics, but the market for those products will take time to develop, too. For any of these solutions to work, they would likely need to be moved along significantly by the carrot of grant money for technology development and the stick of effective regulatory legislation.

Probably the only certain takeaway from a thorough analysis of boat-disposal practices is that if boats are to have an afterlife any time soon, someone has to pay for it. What follows is a speculative example of what that *could* look like:

In October 2012, Hurricane Sandy traveled up the U.S. East Coast and made landfall in New Jersey on the 29th, leaving a wide path of destruction. BoatU.S. estimated that the storm destroyed 65,000 recreational boats, along with waterfront infrastructure, homes, and businesses. So how about the next time a hurricane wipes out a waterfront infrastructure, we rebuild it in recycled composites?

O'Meara explained: "Every dock in the United States, every boardwalk in the United States should be built with recycled composite. Every single one. What are we doing using wood? We get splinters in our feet. That stuff is absolutely falling apart in 20 years, and the first hurricane of course takes it out again." Of the recycled composite material that could be applied to coastal repairs, he said, "This stuff really is good. I mean it is strong. It's a fine product just the way it is. But it doesn't make any economic sense—the wood's cheaper, the virgin [FRP] material's cheaper, remember all that. I'm not trying to say it makes economic sense, but I am saying that with some incentive... like for the state of New Jersey rebuilding the boardwalks at Sandy Hook right now, and that boardwalk is acres and acres and acres of boards. When these natural disasters come up, the government's in such a rush to get everything back in place, they put the same crap up."

As a model, O'Meara points to the U.S. government's production tax credits that have enabled the recent rise of the wind industry. It took almost 25 years and a strong industry push, and now wind is competitive with other types of energy. For the scenario of rebuilding waterfront infrastructure with recycled composites to work, it would make sense for marine insurers to push for that initiative, because creating a waste stream for destroyed boats would save money on disposal costs. "You have to have the solution presold and then they can sponsor doing it the right way and the environmentally friendly way, but if you don't have the solution presold to the Department of Transportation or whoever it is that's going to rebuild the infrastructure, you're going to fail," O'Meara said.

"So you have to have government grant money to first develop the solution fully, with private industry coming in and saying it's of interest, and legislation saying we're going to force it down your throats, and *then* it will happen."

About the Author: *Melissa Wood is the associate editor for* Professional BoatBuilder *magazine.*