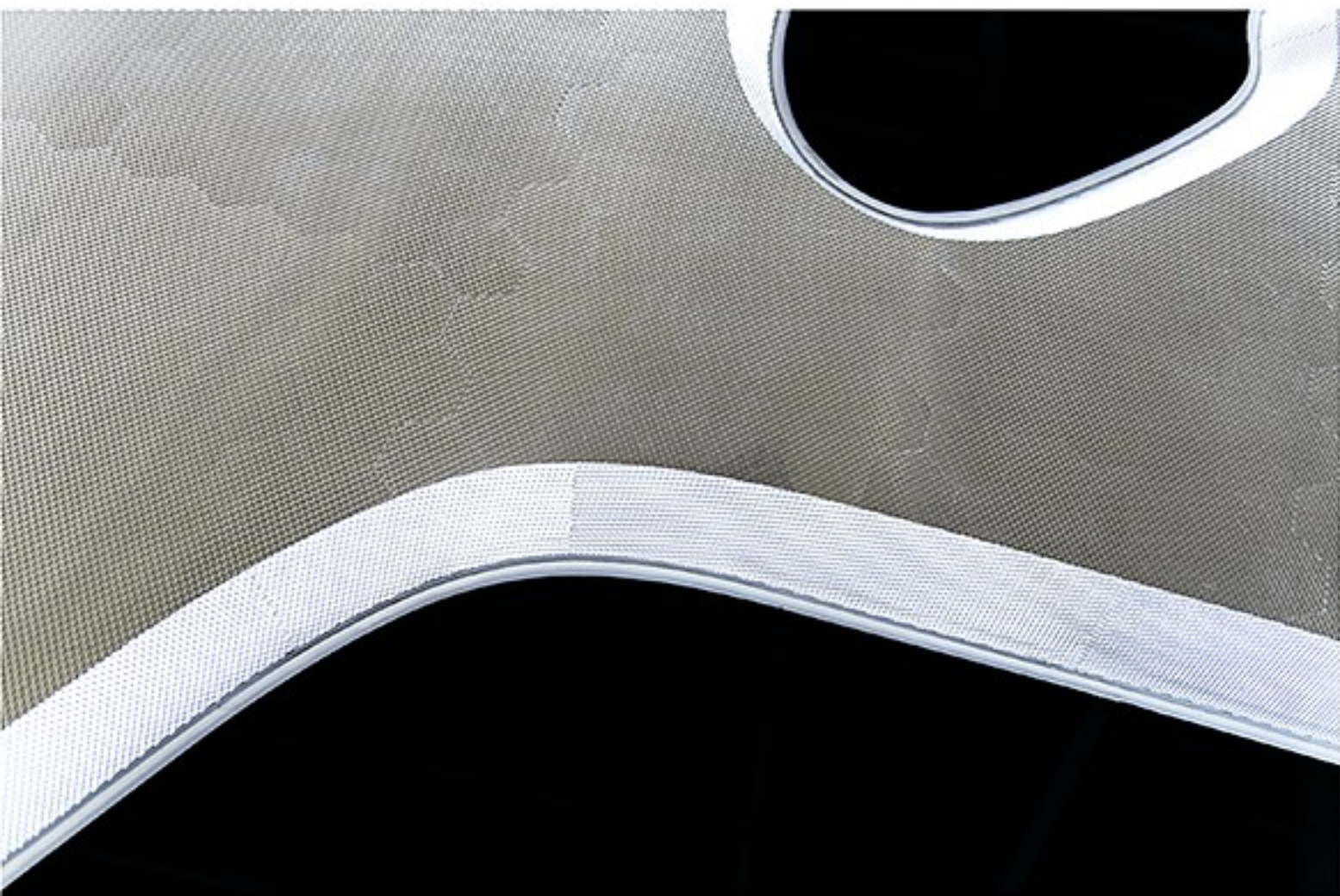


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The importance of sandwich structures and the development of Kordsa's first composite sandwich panel

Innovations in surfboard manufacturing technologies from COBRA International

Coe's and the alternative to phenolic resins



Innovations in surfboard manufacturing technologies from COBRA International

Kym Thompson

The key technical requirements for a surfboard include flex, weight, durability, impact resistance and vibration dampening characteristics. Different market segments place varying importance on these characteristics, with environmental considerations also gathering focus as manufacturers and end users look to reduce their impact on the planet.

Founded in 1978 and unconstrained by traditional surfboard building practices, COBRA has maintained these customer requirements as key inputs into its work, using them to design and develop new products and processes. Some of these new developments have resulted in global innovations invented by COBRA, others are techniques the company has taken from other industries and adapted. Co-developments and technical support partnerships are also an important innovation pathway, and in this paper, we will look at examples of all three types of surfboard development, each driven by COBRA's pursuit of stronger, lighter and more beautiful composite boards.

Masters of EPS

COBRA always believed in the benefits of using expanded polystyrene (EPS) foam cores for their boards. Lightweight, easy to mold or machine to shape, EPS cores can be combined with a huge range of construction technologies for windsurf, surf or stand up paddle boards (SUP).

As COBRA enjoyed great success with its EPS cored windsurf boards, including the legendary 'King Cobra' in 1981, it quickly realized that outsourced EPS blocks did not provide the required quality and consistency, and so prioritized the development of its own inhouse solutions.

COBRA started to manufacture its own composite EPS forming molds that are used to control the shape of the foam core blank as the EPS beads are fused together with steam. This precision molding produces a stronger, more watertight core that also

reduces waste and means the shaped core is ready to use in production, straight from the mold. Cores are tailored specifically to each model in a customer's range and this ability to precisely control the core shape and density, together with exceptional strength and reduced water uptake in the event of a ding, is what really makes COBRA molded EPS the best.

Despite success in larger windsurf boards, applying the benefits of lightweight EPS cores in surfboards did not happen overnight. The market was used to the feel of PU foam surfboards and, even though an EPS core could be only a third of the weight, EPS meant a switch to a new epoxy resin and some people considered the new core to be susceptible to water uptake if the board was dinged.

COBRA worked through this resistance and has been considered to set the standard for surf industry EPS cores ever since, being the first to bring EPS surfboards to market commercially and at a mass production scale with the 1996 Surftech Wood Malibu range (Figure 1).

The Surftech Wood Malibu – mass produced EPS construction coupled with traditional style

The classic long board became fairly obsolete in the late 1960's when the "short board" revolution began and surfers searched for shorter, lighter and more performance orientated designs. It was not until the late 1980's that modern long boards, or 'Malibu's', started to gather a following again, with a gradual rebirth in long board demand that saw some of the legendary designs of the 50's and 60's being recreated in more modern materials.

Alongside this, a demand for more sustainable products and the esthetics of a wooden surfboard that reflect the historical culture of the sport, had seen many brands reintroduce wooden boards into their ranges.

COBRA was ahead of the field on both here, with the introduction of a radical new construction process for the 1996 long

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**FIGURE 1**

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board, The Surftech Malibu: the first mass-produced EPS cored surfboard built at COBRA. The board used COBRA's revolutionary new molded EPS core that was wrapped with thin wooden veneers sandwiched between fiberglass layers in subsequent molding processes, creating a unique surfboard construction that not only looked great, but was light, responsive and surfed amazingly well.

This lightweight and durable wood sandwich technology, in combination with the Malibu's classic lines, meant the board caught waves quickly and turned easily in comparison with the former and heavier boards of the previous era. These traditional designs and styling, coupled with an innovative lightweight construction, proved to be a winning combination (Figure 2).

The Surftech Tuflite – A breakthrough for sandwich composite technology

EPS cores are at the heart of all of COBRA's surf products, but when looking to define the next breakthrough technology for Surfboards, the Tuflite technology developed in collaboration with Surftech has to be a contender.

Already specialists in sandwich construction for larger wind-surf boards, COBRA was able to develop a process to thermoform the rigid PVC foam sheet around the tighter rail surfboards. The PVC sheet was then sandwiched between two epoxy fiberglass layers and vacuum molded around the EPS core.

The first Tuflite board in 1998 was a milestone for COBRA, and the industry, and was a breakthrough for sandwich composite technology in surfing. After roughly 50 years of PU cored polyester boards, Cobra's EPS cores and Tuflite's technology were seen as a turning point in the industry.

Conceived by Surftech founder Randy French with the aim of building lighter but tougher surfboards, the idea was that by switching to a much lighter EPS core, a stronger sandwich construction could be used to skin the board without a weight penalty. The ideas from Randy aligned perfectly with the work being done at COBRA, with the result being the 'Surftech Tuflite'.

Thermoplastic top sheets

2002 saw another COBRA innovation brought to the surf market. Recognizing the potential of clear thermoplastic top sheets being used in kiteboard production, Paolo Cecchetti, CIO, considered the use of these materials in surfboards too.

Surprisingly, when COBRA presented this innovation to its customers, there was no immediate interest. Not to be deterred, Cobra was so confident in this new technology that the group created its own brand – NSP. Thereby bringing to the market, attractive, durable boards that could be produced in volume, at

**FIGURE 2**

The Surftech Wood Malibu features an EPS construction coupled with traditional style.

a competitive price point for the entry level and rental board sector.

Since thermoplastic top sheets (in COBRA's case a blend of materials such as thermoplastic polyurethane and Acrylonitrile Butadiene Styrene) had not been used in surf before, COBRA had to work on a new molding process and also persuade raw material suppliers to tailor product to the new surfboard requirements. The top sheet material needed to be made wider than the standard ski and snowboard products, and inks for graphic prints were modified for improved bonding and UV stability.

Between 2002 and 2010, NSP grew to become the largest selling brand in the world!

The key differentiator in COBRA and NSP's success was the perfect marriage of construction technology with board design. By creating a range of stable, easy to ride, everyday-board designs, COBRA's NSP brand had the boards that surfers wanted. Boards with a bullet proof construction and with crisp graphics printed underneath a clear top sheet that provided the required durability too.

20 years later, some of the very first NSP boards can still be seen on beaches and surf racks around the world, a true testament to the longevity and the success of this project (Figure 3).

"My Board is Whiter than Your White Board!" The Quest for the Ultimate White Board

Since the 1990's, when colored boards with a disco theme were replaced by simpler white boards with basic graphics, surf brands have been searching for the ultimate in whiteness. Initially a way to reduce cost, white boards quickly became the standard and today's boards continue this theme – using a crisp white base to highlight features such as dual cores and carbon fiber rails.

COBRA has led the development of the whitest epoxy boards. Initially, the battle was to prevent epoxy boards yellowing in the

sun, so UV stabilizers were added to epoxy formulations. Working closely with suppliers, COBRA has gone further still with resins including UV optical highlighters that make the boards 'pop', appearing to glow when exposed to UV light.

Crisp white boards also require E-glass reinforcements that are completely clear after lamination. COBRA has challenged suppliers of both classic surfboard cloths and technical biax fabrics to optimize surface treatments, ensuring clarity and whiteness in the finished laminates.

As brands always strive to say "My board is whiter than your white board", COBRA continues to optimize resins (including new 'whiter' versions of bio epoxies), cores and fabrics for the whitest and most UV stable boards.

A step up to carbon fiber

COBRA has been using carbon fiber in its windsurf boards since the 1980's, so it was only natural that some trial surfboards were produced with these lighter and stronger reinforcements. Carbon fiber was interesting as an option to save weight and also to place specific areas of localized stiffness exactly where the designer wanted it.

The surf market in general did not really embrace carbon fiber until 2006 when Hayden Cox, a new generation shaper and founder of Haydenshapes (1997), came to COBRA with his FutureFlex carbon technology and also with a need to scale up.

Haydenshapes had patented FutureFlex, a novel surfboard construction method combining a stringer-less, high density custom-shaped EPS core, laminated with fiberglass fabric, epoxy resin and a parabolic carbon fiber frame around the board's rails.

Hayden's vision from the outset was to reach surfers all over the world and produce enough volume to support a global retail distribution network, whilst also maintaining the brands premium reputation for quality and innovation.

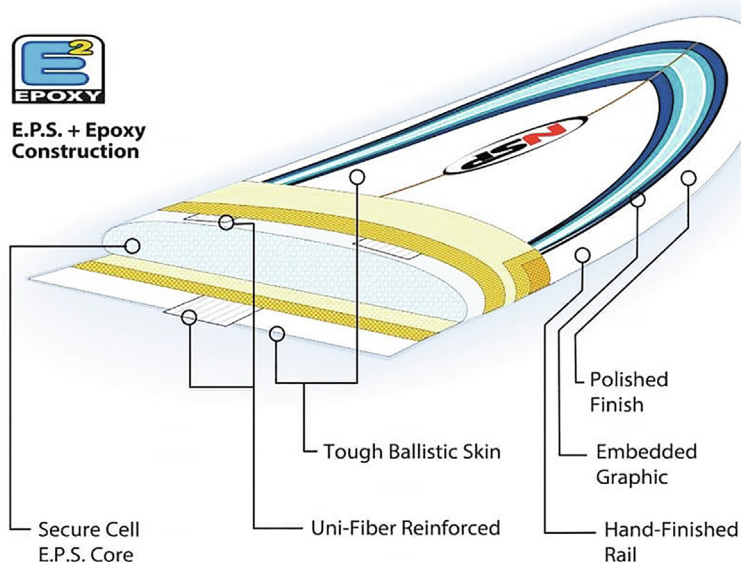


FIGURE 3

Epoxy construction graphic.

COBRA provided the ideal solution with large scale manufacturing capability, industry leading quality control and the experience and supply chain required to incorporate his innovative carbon fiber structure. Building a really strong relationship between designer and board builder has been one of the key elements to the success of the Haydenshapes brand. Hayden himself has spent long periods of time at the COBRA factory allowing him to further develop the concept and technology, defining every detail of the specifications that would be used to replicate them on a high output production basis achieved by work done with Cobra's technical team.

The partnership clearly worked, with the Haydenshapes' Hypto Krypto – a board that appeals to elite level and everyday surf enthusiasts alike - going on to become one of the best-selling board designs as well as a multi-award winner (Figure 4).

The addition of biaxial fabrics in high volume surfboard production

The fiberglass fabrics used to laminate surfboard skins are a key part of the board but are also a material that didn't really develop from the 1950's until well into the 21st century. Lightweight woven fiberglass fabrics (4 oz and 6 oz) were the 'bread and butter' surfboard cloths for decades.

Meanwhile, COBRA had been processing industrial quantities of technical textiles in its other composite parts productions and was both experienced with using a whole range of unidirectional, heat-set and stitched multi-axial fabrics.

Kym Thompson, COBRA's surfboard shaping and construction specialist, first came across a roll of stitched ± 45 degree biaxial glass cloth in one of COBRA's windsurf board production lines in 2006 and took an immediate liking to the flat uncrimped fibers. It did not take long for this new material to find its way into one of COBRA's development boards and the benefits were immediately apparent. With fibers at ± 45 degrees

straight off the roll, all of the fibers in these biaxial fabrics work to help control the boards flex – compared to a traditional woven cloth with a warp and weft laid straight on a board where most of

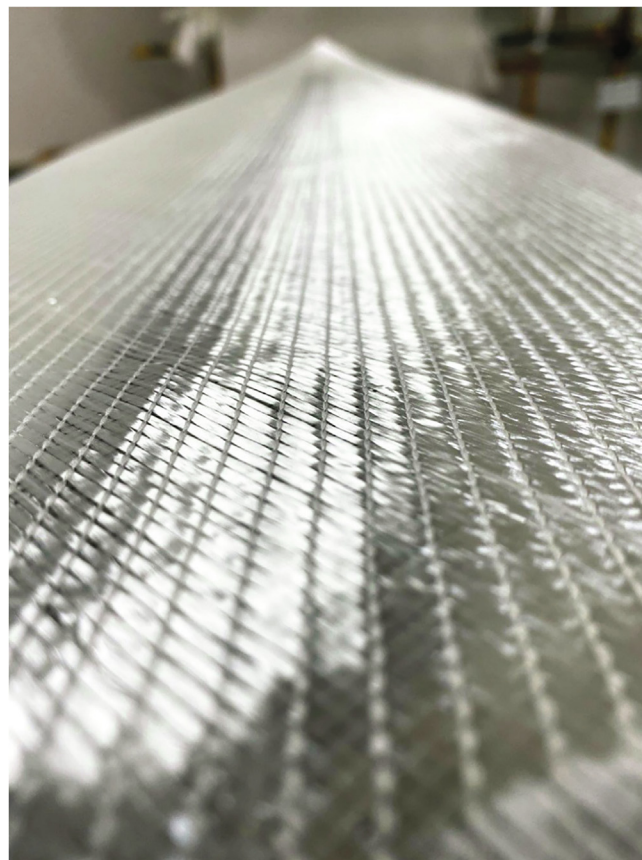


FIGURE 5

COBRA were the first to commercialize the use of biaxial fabrics in high volume surfboard construction.



FIGURE 4

A Haydenshapes board featuring its patented Futureflex Carbon Technology.

the fibers running across the board aren't efficiently taking the load.

COBRA's purchasing team worked with their overseas suppliers to optimize new biaxial fabric versions specifically for surfboards that provided the optimum fabric weights, fiber types and stitch patterns to match the surfboard board laminate and optical clarity requirements.

Perfectly spread plies of straight un-crimped fibers make great composite engineering sense and COBRA were the first to commercialize their use in high-volume surfboard production, with biaxial fabrics now considered a standard material at COBRA (Figure 5).

The introduction of dual core

So why stick to one core material if you can utilize the benefits of multiple core types? Shapers have always liked to experiment, and some, including COBRA's legendary shaper Kym Thompson, started to combine lightweight EPS cores with higher density PU sections in a single board. Kym used wood stringers between the EPS centre section and his board's PU rails. On the water, this new board performed well, with dual cores certainly showing some promise.

Cobra presented this Dual Core foam to longtime partner Surftech, and in 2009 the first mass produced dual core boards at COBRA became the new 'Surftech Short Boards' models. Using the same concept – EPS in the middle and PU rails – the Surftech designs used the vibration dampening properties of the PU foam to allow surfers to dig the rail deeper into the wave and hold the rail in and out of tight turns.

The most recent developments in dual core technology have focused on how best to bond the two foam materials together. Surftech's product development manager Dan Watts and the COBRA team have developed a process using a thin layer of thermoplastic polyurethane (TPU) sandwiched between the PU and EPS cores, creating a strong and highly elastic bond that maximizes the board's rebound and dampening on the fastest waves.

Dual core boards are a great example of the free-thinking approach COBRA use when experimenting with new ideas and materials. Surfers really can have the best of both surfing worlds. One single board, perfect for a range of water conditions, that combines the speed and responsiveness of a lightweight EPS cored board with the traditional feel and vibration control of a PU board (Figure 6).

The NSP CocoMat

The NSP CocoMat surfboard, is a green product success story that developed out of the group's ambition to develop a surfboard with lower environmental impact.

COBRA was used to using GREENLITE® cellulose fiber reinforcements that matched the performance of traditional glass fiber fabrics as well as being fully bio-degradable and compatible with other bio-based resins. In 2010 however, the COBRA team began to search for a locally available bio-fiber that offered the same benefits but with a significantly lower carbon footprint. Fortunately, the solution was just around the corner within the beautiful Thai countryside.

Pierre Olivier Schnerb, CTO, was out biking when he saw piles of discarded coconut husk fibers at a local farm. Gathering a

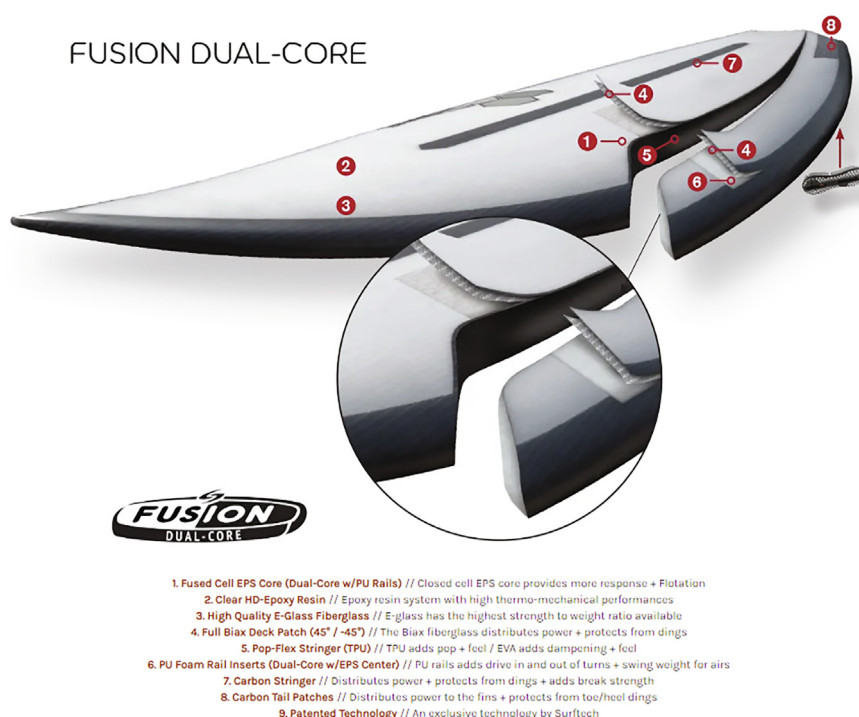


FIGURE 6

The Fusion Dial-Core. Dual core boards combine the speed and responsiveness of a lightweight EPS cored board with the traditional feel and vibration control of a PU board.

small sample Olivier took the materials back to the factory to evaluate.

Initial testing looked promising, with COBRA able to confirm that coconut fiber test panels showed good mechanical properties, impact strength and toughness, as well as meeting production targets for resin absorption and compatibility with epoxy resins.

Seeing real potential in the new fiber, COBRA partnered with NSP Surfboards and the first CocoMat board was laminated and sent for on-the-water testing. Unanimously well reviewed by the testers, who loved the light weight and responsive flex of the new boards, it was time to productionize the CocoMat technology.

Consistent material supply and quality was one of the biggest challenges. Considering the coconut husks as a waste material, the local farmers were not set up to provide a textile material ready for processing. COBRA therefore developed a process internally to clean and separate the raw husk fibers ready for lamination. Well proven board production techniques were modified, with the new fibers used as a randomly distributed 120–140 gsm coco fiber sandwich shell around the molded EPS foam core, before vacuum molding with epoxy resins.

The CocoMat boards' natural coconut fibers are a breakthrough raw material, but COBRA was determined to do more. In 2017, NSP and COBRA announced a partnership with 'Harmless Harvest', a certified producer of organic coconut water drinks, providing a sustainable source for coconut fibers as well as investing in the local Thai organic farms and communities.

CocoMat has been a massive success with more than 15,000 boards produced to date but this success is about more than the boards' bio credentials. The coconut fiber massively improves the boards, producing a product which is lighter, stronger, more resistant to impact, and one that riders love to surf! (Figure 7)

The introduction of bio-based resins to make greener boards

Bio-resins – epoxy resins with an organic carbon content from sustainable resources rather than from oil – offered a fantastic opportunity to make greener boards.

Whilst bio resins initially came with challenges – they had to be integrated into the production process and ensure that boards continued to be as strong, light and UV stable as before – all of these challenges were solvable. It was COBRA's scale that created the biggest issue.

Sicomin, French epoxy specialist and supplier to COBRA for nearly 20 years, was the only supplier able to offer reliable, industrial supply volumes of bio-based epoxies from its GreenPoxy™ range. Significant expansion at Sicomin's South of France production facilities provided COBRA with the confidence to make the switch to bio-based resins, with no compromise on performance or risk to supply. Extensive market testing also showed Sicomin's products had the highest levels of bio-based carbon content.

In 2015, COBRA launched its first bio-based production surfboard range, combining GreenPoxy™ 56 and natural fiber reinforcements, to produce a board with a 40% bio-based content by weight.

In 2018, COBRA achieved a Gold Level Ecoboard Accreditation and the highest level independently- certified surf industry recognition of the sustainable materials and processes used at COBRA.

COBRA always plans to do more, targeting even greener boards and searching for the next breakthrough in bio- resin technology (Figure 8).

Recyclable resins enabling a closed loop recycling process

The surf market has become increasingly aware of the end of life impact that composite products can have on our environment. Epoxy resins build the best surfboards; however these tough and durable systems have traditionally been non-recyclable with limited options for end of life processing. As a result, COBRA has been productionising Aditya Birla's Recyclamine® technology, the first recyclable resin available on an industrial scale.

In 2019, Aditya Birla and COBRA, working with customers MFC and Starboard, initiated a project to develop a closed loop recycling process for epoxy components, taking a massive leap forwards in sustainable composite production.

The new recyclable epoxy systems were used to infuse fin molds and produce fins via RTM, with both parts and molds able to be recycled when no longer required.



FIGURE 7

Natural coconut fibers were seen as a breakthrough raw material. COBRA announced a partnership with 'Harmless Harvest', a certified producer of organic coconut water, providing them with a sustainable source for coconut fibers as well as investing in the local Thai organic communities.

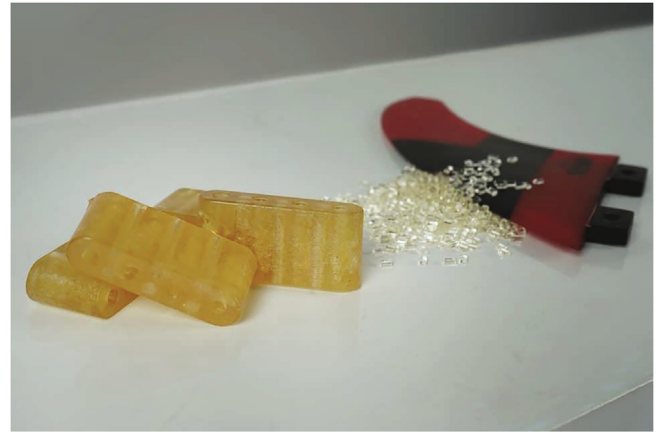
**FIGURE 8**

Sicomin was the only supplier able to offer industrial supply volumes of bio-based epoxies from its GreenPoxy range. In 2015, COBRA launched its first bio-based surfboard range, combining GreenPoxy 56 and natural fiber reinforcements, to produce a board with a 40% bio-based content.

The importance of this new development was recognized by the composite industry, with the project winning a 2020 JEC Innovations Award in the recycling category. First tested in surfboard fins, next steps include the production of the first recyclable surfboard and the integration of recyclable epoxy systems into the composite molds used in surf production at COBRA (Figure 9).

Thoughts from Kym Thompson, COBRA International

Since the company was founded over 40 years ago, COBRA has shown itself to be a key innovator in both product design and

**FIGURE 9**

COBRA has been productionising Aditya Birla's Recyclamine® technology. The new recyclable epoxy systems were used to infuse fin molds and produce fins via RTM, with both parts and molds able to be recycled when no longer required.

manufacturing. As it evolved from Wind Surfing into the Surfboard business, Cobra was always destined to use the company's broad experience to continue on this path. When asked to define exactly what it is that has made COBRA so successful in developing new surfboard technologies, Kym Thompson comments:

"First and foremost, we are a board company with our roots on the beach. The team here brings together an extremely broad range of expertise in composites, and in so many forms of board sports, that the knowledge and ideas never stop flowing and there is always something new to try!

Secondly, we are not constrained by the traditional surf industry techniques and raw material suppliers.

We are big enough that we can have suppliers develop materials specifically for us and we constantly look to new materials and alternative processes that can build an even better product.

Lastly, we really try to understand our customers and their needs. We are happy to work alongside them to develop an innovative technology to match their ideas and dreams for their products. We are also ready to consider ideas a customer may have already, and to help them develop these initial thoughts, using Cobra's high-volume manufacturing expertise, to bring them to a sustainable production scale.

This complete package seems to work extremely well, and we are immensely proud of the reputation that we have built over the years. We thrive on innovation and never waiver from our goal to be the world's best, high-volume, quality driven, specialist board manufacturer".