Going against the grain

Clever use of polycarbonate could revolutionise the way guitars - usually made of wood - are manufactured

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The rock musicians' slang for it is "spanking the plank": that is, playing the guitar, usually energetically and with as much abandon and hairwaving as required.

But perhaps the slang will have to change. For Owain Pedgley of Loughborough University has designed a guitar with a soundboard made from polycarbonate foam instead of wood.

The soundboard is the top part of the guitar - with a round hole in acoustic guitars, or solid in an electric one. Because it resonates with the strings, the soundboard's characteristics have a crucial influence on the sound of the instrument.

The original idea was proposed during Pedgley's PhD by his guitar-playing supervisor, Eddie Norman, and involved making a high-quality learners' guitar out of plastic. In theory, using moulded and engineered plastics might produce a cheaper yet better manufactured instrument. "We knew that the soundboard was the bit to get right," says Pedgley. "Soundboards are traditionally made out of slow-growing spruce."

He turned to the internationally renowned guitar-maker, Rob Armstrong (maker of guitars for the late George Harrison), who insisted that any new material should contain air. "That said, I was looking at foam polymers rather than any other type of polymer," says Pedgley, who only plays keyboards. "We wanted to find a foam polymer that had the same sound qualities as wood."

The knuckle test

Borrowing a trick that guitar-makers use when selecting spruce or cedar, he gave sample sheets of plastic a quick rap of his knuckles and listened closely. He decided on a thin foam polycarbonate, around two-thirds denser than wood, leaving Armstrong the job of using the novel material within an acoustic guitar. Trying a polycarbonate soundboard was the first tentative step towards an all-polymer instrument.

Hard and durable yet easy to mould, polycarbonates are used in bus shelters, conservatory roofs, CDs and your mobile phone. A foamed polycarbonate - think of Aero chocolate but with finer bubbles - holds the air that mimics the sound qualities of wood.

The manufacturer whose product passed Pedgley's knuckle test was Palram Europe, which makes sheets of polycarbonate foam by heating polycarbonate granules to 270C and then extruding the molten mass out of a die and around cooling rollers to create a finished surface. A gas is used to infuse the polycarbonate with millions of tiny bubbles.

Gary Henton, the company's sales and marketing manager, happily talks about microstructures, voids, densities, and pressure drops. He won't however say which gas he uses - it's a secret - to achieve successful foaming."It's sold into the thermo-forming industry where they produce things like suitcases, toolboxes, and containers," says Henton.

"We didn't do anything to improve the product for use in the guitar. The foam polycarbonate resonates like wood would resonate."

That unexpectedly good resonance eventually led Pedgley and Norman to set up Cool Acoustics, a Loughborough University venture backed by funding from the National Endowment for Science, Technology and the Arts. A hybrid wood/polymer acoustic guitar was made, followed by an all-polymer acoustic and a semi-hollow electric. Foamed polycarbonate is used for the soundboards that sit on top of the sound chamber, which produces sound by resonance, transmitting the vibrations of the guitar's strings to the air.

While Pedgley says two unnamed guitar companies from the US and Asia are making some evaluation instruments, he acknowledges that not using wood goes against the grain. Who has ever heard of a plastic guitar that isn't a toy? "Plastic in instruments has always had negative connotations," says Pedgley. "Those kinds of images don't do anything to help your cause but once somebody picks up and plays a guitar, they really are quite persuaded."

Gordon Giltrap is one such musician. His career has been influenced by rock, folk, and classics. Using guitars made by Armstrong, he performs dozens of concerts a year, and played the Cool Acoustics instruments to appreciative audiences.

"What attracted me was the combination of Rob's [Armstrong] design ideas and this new technology from Loughborough," says Giltrap. "If you can make an instrument out of synthetic materials that sounds like wood, you think hurrah. Believe me, this guitar does sound like wood."

Giltrap can hear the changes in sound quality, saying that the bass end response is comparable to Gibson guitars costing thousands of pounds. The Cool Acoustics soundboard technology - which won't warp, split, or dent - gets top marks.

"It really is a fine-sounding guitar. The treble probably gives it away a little bit. It doesn't quite sound as woody and as deep as you would hear from a traditional instrument," says Giltrap. "The dream has always been to produce a guitar at a budget price that sounds fantastic. If a maker can produce a guitar out of polymer and it sounds great, people will play it."

Endangered species

Impending shortages of fine wood may force guitar companies to look for alternatives anyway. Brazilian rosewood, used for the back and sides, is now an endangered species, for example. Classical guitarist Raymond Burley loves the sound of wood. One of Britain's most experienced guitarists, he has worked with some of the finest orchestras. He finds the idea of foamed polycarbonate surprising.

"I cannot imagine what the sound would be like," says Burley, who points to a long tradition of using wood. "It's like making a violin out of plastic."

Burley's guitar-maker, Christopher Dean, quickly homes in on what polycarbonate lacks by mentioning the characteristically long grain in spruce, which gives strength. His customers - he makes 16 guitars a year - look for a sound that's unique to him. A fine performance across treble, mid range and bass is a result of skill, top-quality wood and clever internal bracing.

"I'd be terrified if this material produced guitars of great quality. But I doubt that would happen," says Dean. "Most people are happy with what they get. I don't know that another material would improve that greatly." But he plans to find out more about the polycarbonate phenomenon.

Fellow guitar-maker Armstrong is more certain. "I'm convinced that it's possible to make a good guitar from materials other than wood," he says. "It was a good opportunity to continue to explore what I believe - Stradivari only choose wood because he didn't actually have a lot of other choice."

There's a cost advantage to using a polymer for a soundboard, too. "A decent spruce blank will cost upwards of £15 to a large-scale guitar manufacturer who buys in bulk," says Pedgley. "The foamed polycarbonate sheet is about one-fifth of bulk purchase cost." Guitar-makers such as Dean look for top-quality spruce that is between 100 and 150 years old and will pay around £50 for it.

Achieving the right sound isn't everything for Pedgley. New materials open up other opportunities, and he enviously mentions the original eye-catching Apple iMac. "Imagine a guitar which is as stunning as that. It's going to be totally radical and, if you get it right, create a design icon, too," says Pedgley.

But some rock musicians, including Pete Townshend of the Who, may not agree, no matter how cool a new-generation instrument looks. Foamed polycarbonate has one other characteristic that wood does not offer: it's tough yet surprisingly flexible. Ending a gig by whacking your guitar on the stage just might see it bouncing rather than shattering.