

# Wetsuits – A Materials Review

By Paul McCutcheon, Centre for Alternative Materials and Remanufacturing, November 2023



University  
of Exeter

When people think of wetsuits they think of neoprene, but in recent years awareness of the environmental issues of neoprene and new developments have changed the commercial landscape. Customers are demanding more sustainable options and with that companies are searching for the best options, balancing price, performance and sustainability to meet the differing needs. However, alongside that are the inevitable marketing campaigns, all competing to show that theirs is the most sustainable, best option out there. Confusing is an understatement of the current materials on offer, so this article aims to explain the options and status of the industry.

Wetsuits can be different thicknesses and come with or without linings depending on the intended use and personal preference, but at the centre of it all is foamed rubber. The foaming agents used in the manufacturing process add small nitrogen bubbles into the foam and this is key for providing the thermal insulation to keep you warm. Originally this material was developed by DuPont and become known as neoprene, but with new ingredients starting to be used for making foamed rubber we are seeing a plethora of new brand names.

## The raw ingredients:

Neoprene, also known as polychloroprene is a polymer of chloroprene molecules and it is the approach to the manufacture of these chloroprene chips that has largely led to the array of new materials available. The options to make chloroprene can be:

1. Petrochemical based methods – generally starting from materials like acetylene or butadiene
2. Calcium carbonate as a feedstock (base material) – this can be by:
  - a. Mining from limestone rocks – depending on the manufacturer, the resulting foamed rubber will differ. Yamamoto claims their specific range of Japanese limestone rubber is the best performing, with less moisture absorption, and a more hexagonal shape of the cells enabling a higher packing rate and volume of air to be in the material, with better thermal performance.
  - b. Crushed seashells such as oyster shells
3. A mixture of any of the above methods.

With all of these options, various other additives are then added into the process, such as carbon black, and then processed/baked with foaming agents to end up with the final foamed rubber.

The alternative feedstock materials for making foamed rubber for wetsuits are:

1. Natural rubber – derived from rubber plants such as the Hevea tree. Yulex pioneered this technique, with its Yulex® rubber, but there is also a version of the Yulex® rubber now available and marketed by Sheico.
2. A combination of natural rubber and calcium carbonate (from oyster shells) – marketed as BioPRENE from Sooruz or Bio 2 from the new player in the market, Shawve.



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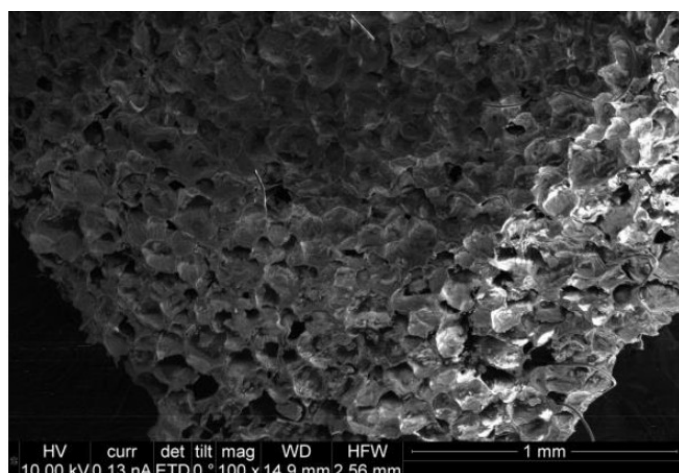
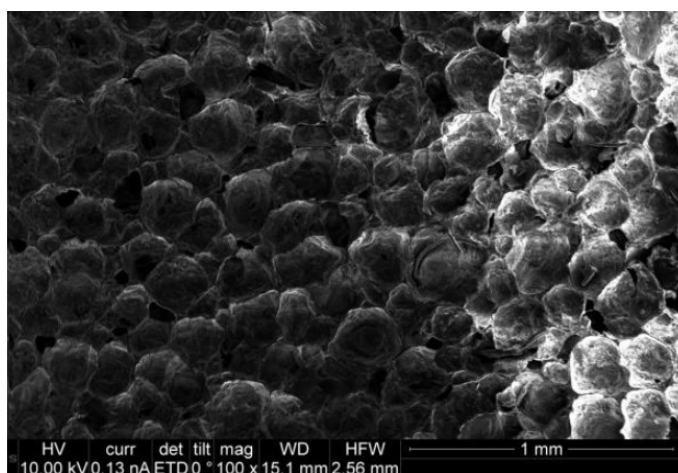
**Brand names for materials:**

Despite the array of brand names for the materials that are now available, it is worth noting that one company, Sheico, dominates in the global manufacture and supply of materials for wetsuits, with them supplying many of the leading brands. Some of these have Sheico manufacture the full wetsuit whilst others manufacture them in-house or use another manufacturer for the wetsuit production, with Sheico providing the material. Alternative material suppliers include Yamomoto (limestone, mined from rock), and Yulex (natural rubber - plant based).

A summary of some of the rubber foam options available from brands marketed as sustainable alternatives to traditional petrochemical based neoprene are shown below. Please note these are provided as of 2023 and written to the best of the author’s knowledge based on marketing material available. They do not represent the whole range offered by any one company, but just the most sustainable option they provide.

Company	Material Brand name *	Details of foamed rubber used *
Sen no sen, Vissla, C-skins, Tiki, Needessentials, ION, Quicksilver, Hurley, Yeti, Rip Curl	Limestone (mined)	Generally mined limestone (but some options may be petroleum based)
Matuse, Neil Pryde, Feral, Lunasurf, Isurus	Geoprene / Yamomoto limestone	Mined limestone – marketed as the leading performance material – better insulation and less moisture absorption (needs independent testing). Various grades available.
Nine Plus	Yamomoto limestone (with majority smooth skin, instead of fabric outer layer)	
Snugg, Ridge Wetsuits, Seventhwave, 7TILL8	Yamomoto limestone (wetsuits generally made-to-measure)	
Dakine	Friendlyprene	Additive added to Yamomoto limestone that is designed to help material biodegrade in a biologically active landfill (appropriate facilities not widely available)
Picture	Eicoprene	Limestone based (used to use Naturalprene – 85% natural rubber, 15% synthetic chlorine rubber from plants, but not currently used)
Deeply	Mineralprene	Calcium carbonate from a mix of mined limestone rock and oyster shells
Xcel, O’Neill Blueprint, Alder, Prolimit	Non-specific	Calcium carbonate from oyster shells used as core ingredient (various other ingredients)
Sooruz	Oysterprene	
Sooruz	Bioprene	Oyster shell based, mixed with natural rubber and other ingredients
Snawve	Bio 2	
Billabong	Organiprene	
Norrna	Naturaprene	Natural rubber (plant based).
Patagonia, Finisterre, Srfce , Sen no Sen, Wallien, Oxbow	Yulex	

*\*Please note, not all the wetsuits made by the companies listed above will be made of the material mentioned and many may offer other alternatives. Some, such as Srfce (offering limestone based neoprene, Yamomoto limestone based neoprene and Yulex), are very transparent about this and state what the material is, for others you have to look very closely. When brands mention using recycled tyres and other recycled rubber in their foam this is likely to be for a smaller proportion of the feedstock and typically for the carbon black aspect of the mix.*



*Internal cell structure of foamed rubber*



### Other sustainability initiatives:

Most brands are keen to highlight their sustainability credentials and even those using petrochemical based foamed rubber will showcase other areas where they are being 'green'. Some things you should look for as standard are:

- Recycled tyres and in some cases recycled neoprene offcuts are used for fillers and additives (such as carbon black) used in the manufacturing process
- Liners – these are often now made from recycled materials
- Solvents for putting liners on – there has been a general move to water based solvents
- Dope dye (for liners) – masterbatch colourant added to the polymer melt before creating the yarn instead of dying after knitting fabric (saves water, energy & polluted rinsing water)

### So what is the most sustainable?

What is really needed is a full life cycle assessment of the complete wetsuit from cradle to grave for the different product options in order that an informed decision can be made. For now we have to go on the view that natural rubber from sustainably managed forests, or seashells (whilst there are enough seashells as a waste product, and not farmed specifically for the shells) are better than mining options (petrochemical or limestone rock), but there is more to it than that. A full lifecycle would take into account all components of the wetsuits, the manufacturing processes, logistics/transport, durability, end-of-life options etc.

At the moment there are little documented findings and these generally only take into account the manufacture of the foamed rubber.

One of the more detailed reports is provided by Yulex:

<https://www.yulex.com/post/rubber-chronicle-19-co2e-emissions-of-natural-rubber-neoprene-geoprene-and-sbr>



Wetsuit linings from recycled material

### Recycling and Repair

Recycling and end-of-life options – Recycling of wetsuits into material that can be used for making new wetsuits is difficult because of the multiple materials and the cross linking in the polymer chains, which prevents the rubber foam being remelted into the same material. Various processes of devulcanization can be used to remove cross linking and incorporate some end of life material back into a mix of virgin material to make new rubber products. Other options include pyrolysis to produce carbon black from the rubber products, or turning it into a rubber crumb, which can be mixed with other materials for use in road surfaces, playgrounds etc, or chemical recycling to try and get the material back to its original molecular building blocks.



Shredded wetsuits for recycling trials

Whilst we wait for these processes to be further developed there are still options for the consumer. Firstly make your suit lasts as long as possible by looking after it, making repairs and if there is still life in it when you have finished with it look at selling it or donating it. If it's no longer usable then there are a range of companies offering to take back wetsuits and liaising with organisations who are then using the material for new products like yoga mats and bags. A fairly comprehensive list of offerings is provided by the wetsuitsyou website: [https://wetsuitsyou.com/wetsuit-recycling-is-important/?utm\\_content=cmp-true](https://wetsuitsyou.com/wetsuit-recycling-is-important/?utm_content=cmp-true), although circularflow.net is not mentioned and they are worth looking into, with partnerships with a lot of the leading wetsuit brands.

Hopefully in the future new ways of recycling, combined with new materials will result in true recycling into the same material through either mechanical or chemical recycling processing, or we will have a truly biodegradable option, but until that time we have to maximise the life of the product and material.

Repairs – Companies offer warranties and repairs <https://surfcare.co/blogs/blogs/which-wetsuits-have-the-best-warranties> and there are also dedicated repair companies such as Bodyline. Simple repairs can be done at home with adhesives such as black witch or Bostik 2402.

## What more can be done?

- Manufacturing locations – In many industries there is a move to a more distributed manufacturing approach, reducing risk but also less transport requirements for the materials and products. The supply of materials used for wetsuits is dominated by a few key players and so logistics will continue to be an issue for the wetsuit industry, until more manufacturers, or facilities are set up across the globe.
- Glues to join the panels together – Little information is provided about the adhesives used to bind the panels together, with these likely to be solvent based polychloroprene rubber glues. It is critical that these seams have a similar stretch to the panels for comfort and performance and there have not been many publicised developments looking at more sustainable adhesives for the panels (unlike the lamination of the linings, which have moved to water based adhesives).
- Liners – These are typically made from polyamides (eg. nylon) or polyester (eg. PET), often from recycled sources, but the issues come with separating these from the rubber at the end of life. Joined to the rubber with adhesives, the process of removal (which may require the use of solvents), can be both costly and time consuming.
- Packaging – Companies vary in their approaches, but this is often an overlooked aspect. The use of biodegradable or reusable packaging is important not only in shipping to the consumer but also during transit from the manufacturer.
- Seams – Currently seams are glued and then stitched (where linings are used) and sometimes taped. Seams strength is important for performance, but also must keep water out and remain intact. This is an area that more research can be carried out in to improve performance and durability, whilst allowing easy repairs and/or end of life disassembly.
- Alternatives to rubber – Rubber is inherently difficult to recycle because the manufacturing process causes the polymer chains to cross-link, meaning the material can not be melted back down and reused in the same process. So an alternative, more easily recycled material is the ultimate goal. Is there a different material – perhaps a bio-derived thermoplastic that can be used? Or is there a completely new approach to keeping us warm in the water, whilst maintaining flexibility? A development in this space, really would be transformative for the industry.

### Summary:

The wetsuit material landscape is a complicated one and transparency and data is what we really need at the moment. There isn't the perfect solution and we have to be educated about the options available and make our own informed decisions. This means companies can promote their sustainable initiatives, but we need transparency about all the materials that go into their wetsuits. So do your research, look after your wetsuit and watch out for new developments in this evolving and exciting area of materials development.

