INSPIRED BY NATURE: A NEW MATERIAL FOR WIND TURBINE BLADES

Why do we need new materials for wind turbine blades?

UK target of

50GW

of offshore wind energy by 2030

In order to capture more energy, wind turbines are getting bigger – current offshore wind turbines are

260m

tall; almost twice the height of the London Eye

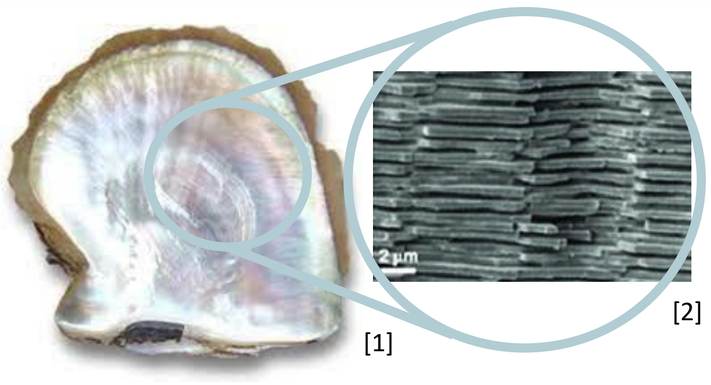
Larger blades are subject to **greater forces from gravity and more impacts**

Current materials are unable to withstand these forces, therefore new materials are required

KEY TAKEAWAY: Bigger wind turbine blades require stronger and tougher new materials.

How can we take inspiration from nature to create a stronger, tougher new material?

Nacre is **5x tougher** and **1000x stronger** than its constituent parts.



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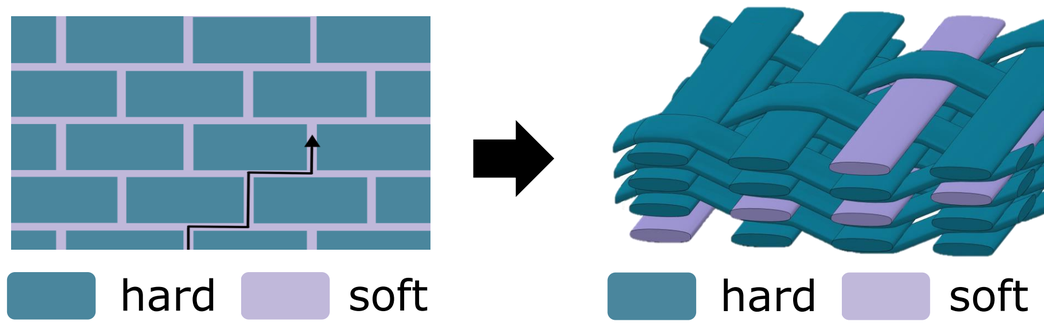


Mother-of-pearl, or **nacre**, was identified as a natural material with remarkable strength and toughness. Its complex structure containing both soft proteins and a hard mineral material means that it is **much stronger and tougher than the sum of its parts.**

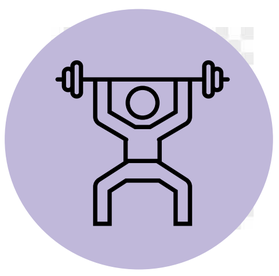
The complex structure observed in mother-of-pearl resembles a **"brick-and-mortar"** structure. This structure results in cracks "zig-zagging" through the material. Increasing the crack path means the material takes longer to break.

Soft polymer fibres and hard carbon fibres are woven together **to replicate the proteins and minerals in mother-of-pearl** and are arranged in a 'staggered' structure to replicate its structure. The fibres are then set in resin similarly to the carbon fibre found in bike frames.

KEY TAKEAWAY: Soft polymer fibres are woven together with strong carbon fibres in a structure replicating strong and tough mother-of-pearl.

Can we make a stronger, tougher new material by taking inspiration from nature?

When hit with a hammer in a Charpy impact test, the novel material design withstood **20% more energy** than the same material woven only with carbon fibre. This material could withstand the larger impacts experienced by larger wind turbine blades.



The material was also found to be **as strong as many metallic alloys and twice as strong as the glass-fibre** currently used in wind turbine blades.

When a stretching force was applied in a tensile test, the novel material was found to have a **stiffness of 10GPa.** Balsa wood, which is currently used in wind turbine blades, has a stiffness of 7GPa. This means the blade could withstand greater bending forces resulting from gravity.

Polypropylene is an inexpensive material that can come from recycled sources – this material could **be cheaper and more sustainable than pure carbon fibre or glass-fibre**. It is also less dense and could **reduce the total weight of the larger blades.**

KEY TAKEAWAY: The novel material design is tougher, stronger and lighter than the materials currently used in wind turbine blades.

NEXT STEPS: Future work will include using **computational models** of the material to investigate the design further and to **optimise the material properties** for its application in wind turbine blades.

WEAVING A MORE SUSTAINABLE FUTURE BY TAKING INSPIRATION FROM NATURE

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References
[1] Devitt (2015), 'Mother-of-pearl's genesis identified in mineral's transformation', WISC News Edu
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With acknowledgements to:
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