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## Floppy when wet: Sea cucumber inspires new plastic

19:00 06 March 2008  
NewScientist.com news service  
Mason Inman

The skin of sea cucumbers was the inspiration for a new material that can change dramatically from rigid to floppy when soaked in water.

The material could be useful for brain implants that cause less inflammation, researchers say. A version switched by electric pulses that is currently in development could find many more uses – such as clothing that morphs into armour.

Sea cucumbers' skin is usually supple, allowing them to slide through narrow spaces between rocks and corals. But when touched a defensive reaction makes their skin go rigid in seconds, thanks to enzymes that binds protein fibres together. A second set of enzymes can break those bonds to make the skin soft again.

Sea cucumber skin can become more than 10 times stiffer in this way, but the new material can go further – softening by more than 2500 times. Simply soaking the transparent material in warm water for 15 minutes is all it takes to complete the transformation. After drying out it is identical to its original rigid state.

The new material behaves differently to more common materials that go floppy in water like foam or cardboard. It changes its properties more dramatically and does not take on large amounts of water when soaked.

### Cellulose 'whiskers'

Developed by [Stuart Rowan](#) and [Chris Weder](#) of Case Western Reserve University, Cleveland, Ohio, US, the material is a polymer made from two different compounds and shot through with microscopic cellulose fibres. "It's directly inspired by the sea cucumber," Rowan says.

"We have the elastic polymer, so that's the mimic for the sea cucumber skin, and then we put in the cellulose whiskers," Rowan says. "You can get these from paper pulp, but we got ours from another little sea creature called a tunicate."

When dry, the cellulose fibres keep the material rigid by forming a scaffold held together by hydrogen bonds. But water molecules are better at forming such bonds, so when wet, the fibres lose their grip on one another and bond to the water molecules instead.

The material could be useful for electrodes implanted into the brain, such as for patients with Parkinson's disease or for brain control interfaces, the researchers say.

### Electric switch

The rigid material could easily be inserted into brain tissue, before softening into its floppy state. That would reduce the problems with inflammation solid electrodes can cause.

Rowan says they're now working on versions of the material that switch stiffness in response to a pulse of electricity.

"I think it is one of the most exciting recent opportunities in the design of new materials," says [Craig Hawker](#) of the University of California in Santa Barbara, US. "It will open the door to applications in a number of different fields."

"One can imagine protective clothing for example, which is flexible and comfortable to wear, but becomes rigid and protective when necessary," Hawker adds. "This is essentially what sea cucumbers use this process for." [Robert Langer](#) of Massachusetts Institute of Technology, US, adds, "perhaps it could also be used as a stimuli responsive system for drug delivery".

Journal reference: *Science* (DOI: 10.1126/science.1153307)



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Sea cucumbers switch their skin from flexible to rigid using enzymes; the new material performs the same trick using water as the trigger (Image: Science)

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