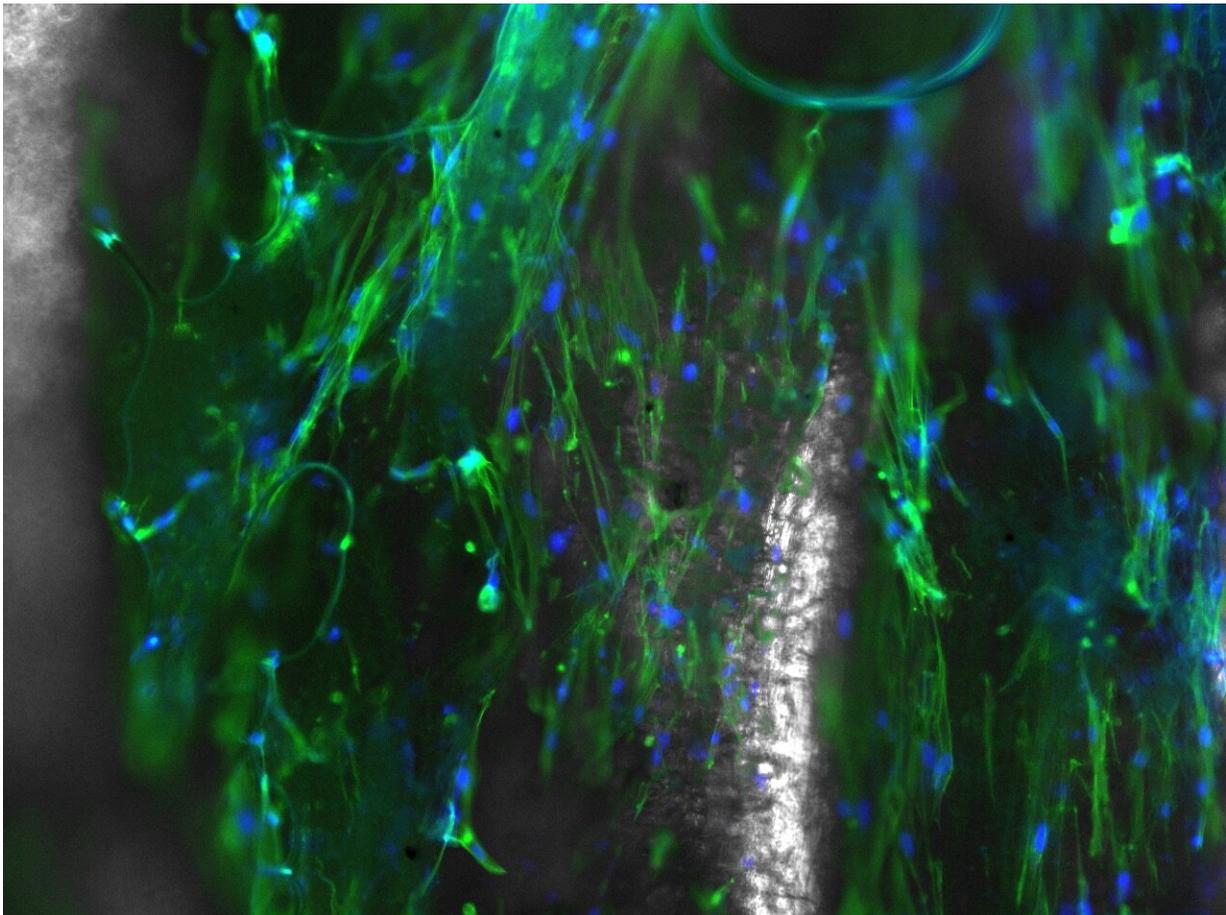


Engineers craft the basic building block for electrospun nanofibers

March 27 2019, by Allison Mills



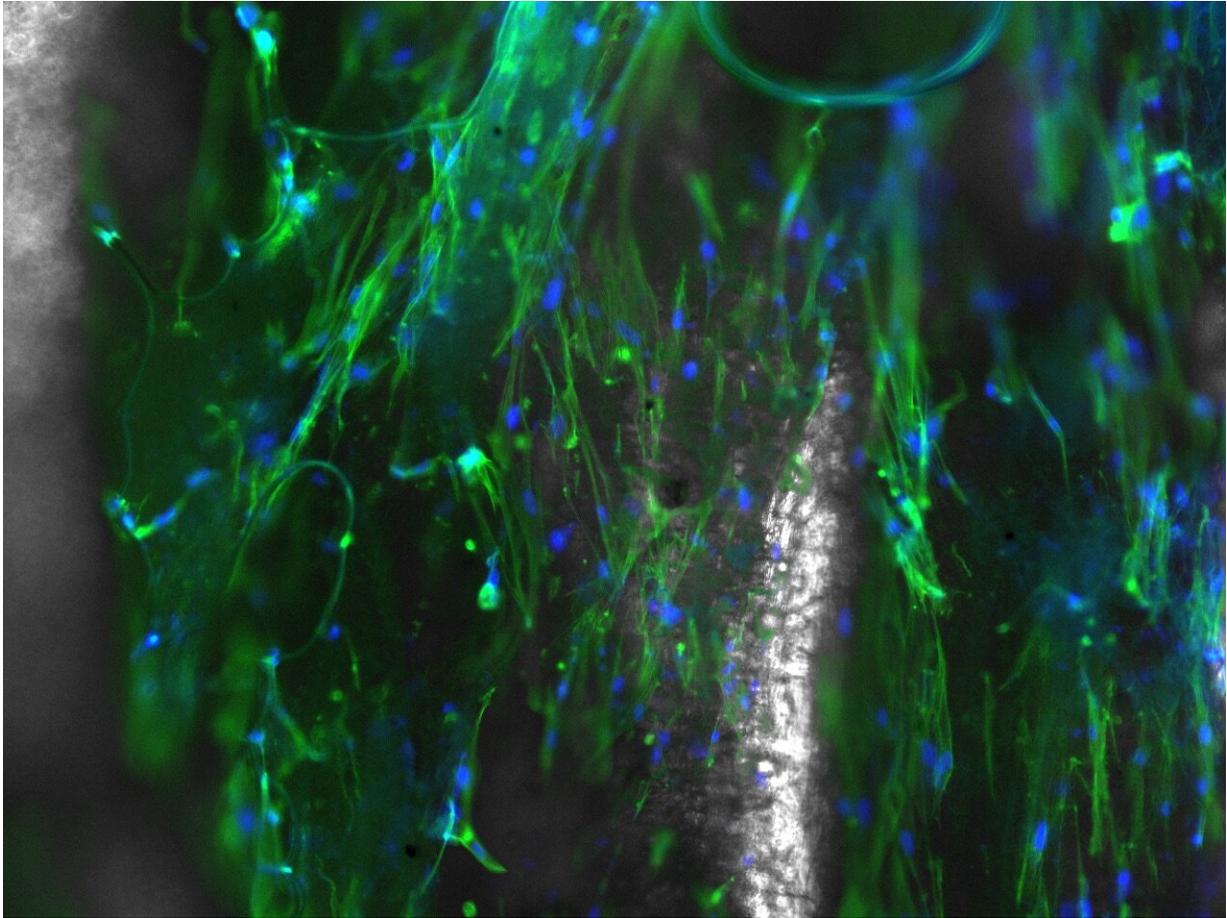
Although the polymer material texture is visible to the naked eye, microscopic images reveal the intricacy of the pockets and strands in the structure. Credit: Smitha Rao/Michigan Tech

Electrospinning uses electric fields to manipulate nanoscale and microscale fibers. The technique is well-developed but time-intensive and costly. A team from Michigan Technological University came up with a new way to create customizable nanofibers for growing cell cultures that cuts out time spent removing toxic solvents and chemicals. Their work is published in *Materialia*.

Smitha Rao, assistant professor of biomedical engineering at Michigan Tech, led the research. She said the approach is innovative, "we're coming at this completely sideways," and the team focused on streamlining electrospun nanofiber production. Nanofibers are used as scaffolds, made up of strands and pockets, that can grow cells.

"We want an assembled, highly aligned [scaffold](#) that has ideal structures and patterns on it that cells will like," Rao said. "Take a cell, put it on [porous materials](#) versus elastic materials versus hard materials, and it turns out the cell does different things. Usually you use varied materials to get these diverse characteristics. Cells respond differently when you put them on different surfaces, so can we make scaffolds that provide these different conditions while keeping the materials same?"

In a nutshell, yes. And making customizable scaffolds is surprisingly simple, especially when compared to the laborious casting and additive processes typically used to produce scaffolds suitable for electrospinning. Plus, Rao's team discovered a pleasant side effect.



Cells grow differently on different kinds of surfaces. Smitha Rao's lab wanted to see if a single kind of scaffold could generate this diversity. Credit: Smitha Rao/Michigan Tech

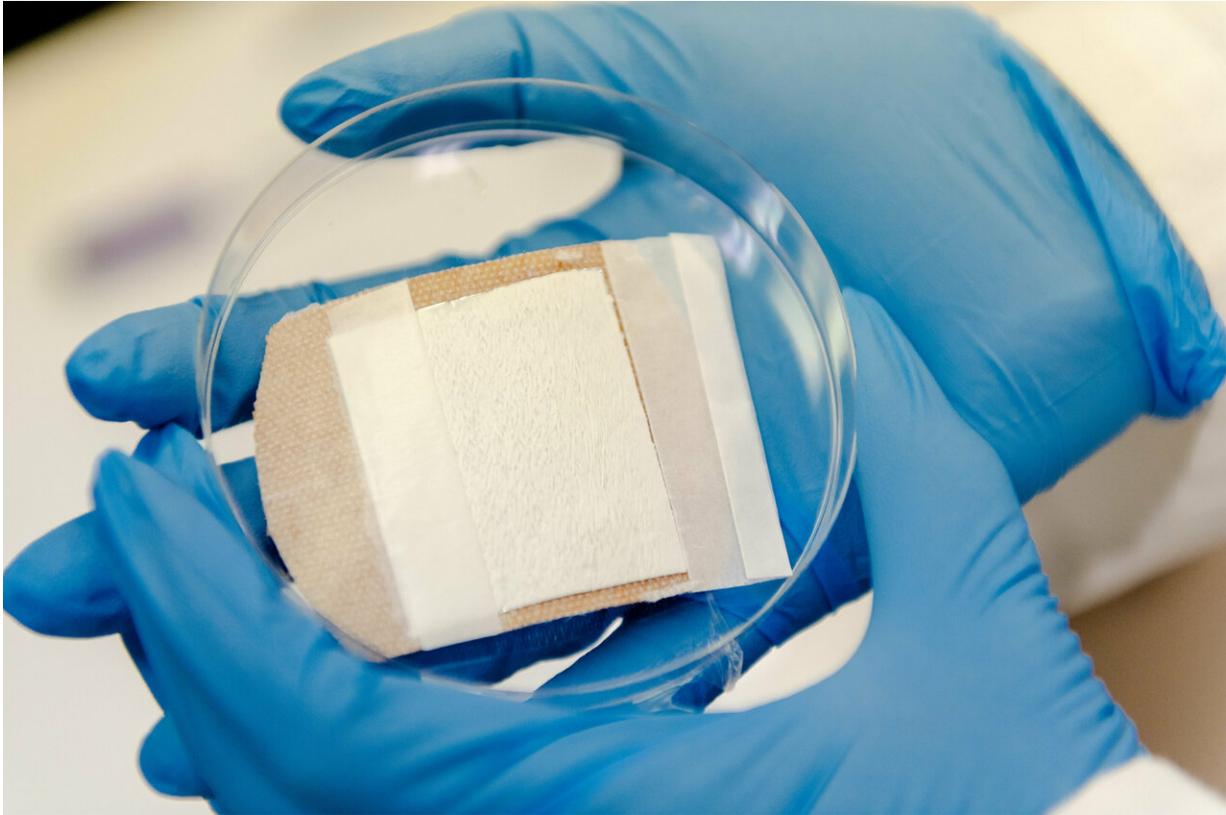
"We take the polymers, then we put them into solutions, and we came up with this magical formula that works—and then we had to go electrospin it," Rao explained, adding that the team noticed something odd during the process.

"We saw that the cells aligned without us applying anything externally. Typically, to make them align you have to put them in an electric field, or put them in a chamber and agitate the scaffold to force them to align

in a particular direction by applying external stresses," she said. "We're basically taking pieces of this scaffold, throwing it in a culture plate and dropping cells on it."

When spun in an electric field—imagine a cotton candy machine—the self-aligning cells follow the strand-and-pocket pattern of the underlying nanofibers. Rao's team, including lead author and Ph.D. student Samerender Nagam Hanumantharao and masters studentCarolynn Que, found that varying [electric field](#) strengths result in different pocket sizes. At 18 kilovolts, the magic happens and the fibers align just so. At 19 kilovolts, small pockets form, ideal for cardiac myoblasts. At 20 kilovolts, honeycombs of pockets expand in the fibers. Bone cells prefer the pockets formed at 21 kilovolts; dermal cells aren't picky, but especially like the spacious rooms that grow at 22 kilovolts.

Rao's team tested a variety of polymer mixes and found that some of the most common materials remain tried-and-true. Their magical two-polymer blend let them manipulate the nanofiber pocket size; a three-polymer blend made tweaking the mechanical properties possible. The polymers include polycaprolactone (PCL), biodegradable and easy to shape, and conductive polyaniline (PANI), which together made a two-polymer blend, which could be combined with polyvinylidene difluoride (PVDF).



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"Because polyaniline is conducting in nature, people can throw it into the fiber matrix to get conductive scaffolds for cells such as neurons," Rao said. "However, no one has used these materials to manipulate the

process conditions."

Being able to use the same [materials](#) to create different nanofiber characteristics means eliminating chemical and physical variables that can mess with experimental results. Rao hopes that as more researchers use her team's blends and process that it will speed up research to better understand neural mechanisms, speed up wound healing technology, test cell lines and boost rapid prototyping in biomedical engineering.

"We're trying to simplify the process to answer a highly complex question: how do [cells](#) proliferate and grow?" Rao said. "This is our basic building block; this is the two-by-two Lego. And you can build whatever you want from there."

More information: Samerender Nagam Hanumantharao et al, Self-assembly of 3D nanostructures in electrospun polycaprolactone-polyaniline fibers and their application as scaffolds for tissue engineering, *Materialia* (2019). [DOI: 10.1016/j.mtla.2019.100296](https://doi.org/10.1016/j.mtla.2019.100296)

Provided by Michigan Technological University

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