Researchers develop an alternative to pacemakers in the form of a hydrogel

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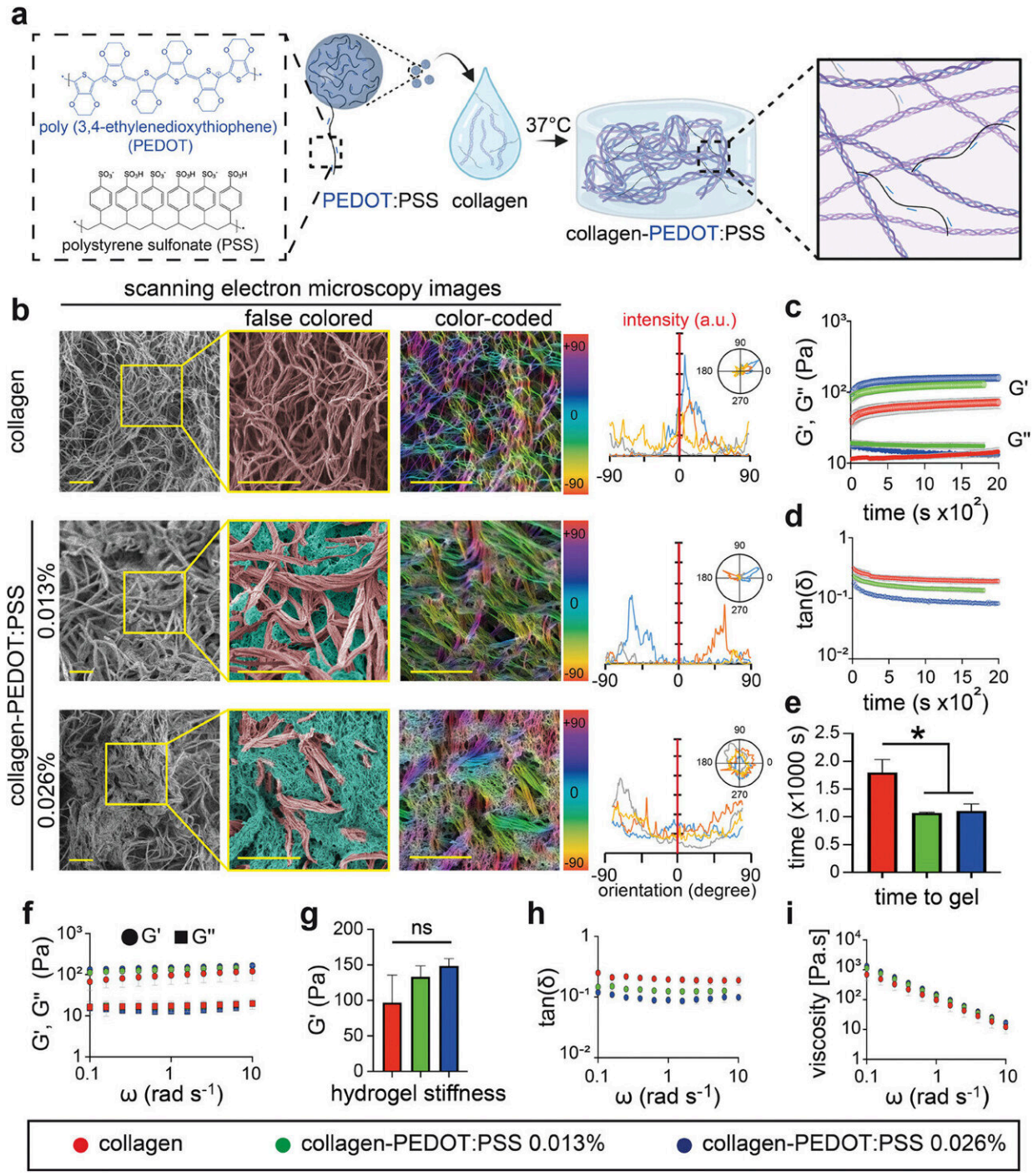

Hydrogel formation and characterization. a) Schematic illustration of hydrogel formation. b) Representative scanning electron microscopy (SEM) images of critical point dried hydrogels and their magnified false-colored regions of interest (ROIs) together with color-coded images and quantified orientation distribution of fibers in each composition. c–e) Characterization of gel

formation based on time-sweep rheology showing: c) evolution of storage and loss moduli, d) loss tangent, and e) time to gel formation. f) Rheological analysis of viscoelastic properties of hydrogels showing the evolution of storage and loss moduli over angular frequency, g) hydrogel stiffness based on storage modulus, h) loss tangent, and i) viscosity at different angular frequencies. Credit: *Advanced Materials* (2024). DOI: 10.1002/adma.202403642

A heart attack is a life-threatening condition, with patients remaining at risk of premature death long after the actual attack—50% to 60% of patients die subsequently as a result of sudden cardiac death, triggered by cardiac arrhythmia.

The most effective treatment currently available—a pacemaker—stops cardiac arrhythmias. However, it cannot prevent them from reoccurring. Researchers at Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) and the University of Bonn have developed a gel that should do precisely that.

Heart attacks remain life-threatening even after the actual attack has passed

A heart attack is not only an acutely life-threatening condition, it also entails severe long-term health risks. Why is this the case?

"The problem is the scars that result from a heart attack. Unlike healthy tissue, they disrupt electrical signals, thereby preventing the cardiac muscle cells from communicating effectively with each other and beating in rhythm," explains Felix B. Engel, Professor of Experimental Renal and Cardiovascular Research at FAU and at Uniklinikum Erlangen.

Pacemakers only treat the symptoms and not the underlying problem

The most effective treatment to date to stop cardiac arrhythmias and prevent sudden cardiac death involves surgically implanting a device known as a pacemaker. They are also referred to as implantable cardioverter defibrillators, or ICDs for short.

They recognize ventricular arrhythmias and give an electric shock to the heart, resetting it to the normal rhythm. The problem: pacemakers are not able to prevent the underlying problem, i.e., the occurrence of cardiac arrhythmias.

Furthermore, the frequent shocks of the pacemaker continue to damage the heart, cause considerable mental distress for patients and impair their quality of life as a result.

A gel to prevent cardiac arrhythmias

A team of researchers at FAU has developed a hydrogel consisting of collagen as an effective and well-tolerated carrier substance and the electrically conductive substance PEDOT:PSS. This gel should prevent cardiac arrhythmias.

How exactly does that work? "We can inject the gel directly into the scar tissue in the heart. This essentially electrifies the heart tissue, allowing cardiac muscle cells to communicate more effectively with each other again," explains Dr. Kaveh Roshanbinfar, a research associate in the Engel group and the lead author of the study published in *Advanced Materials*.

It will be a while before the gel is available. Initial experiments in animal

models have indicated that the hydrogel successfully prevents arrythmias and ventricular tachycardia, thereby possibly rendering the high-energy shocks produced by ICDs obsolete. However, a lot of research still remains to be done until patients can use the hydrogel.

Prof. Dr. Felix Engel explains, "One aspect is that scars left in humans after a heart attack are much more complex than those in mice, for example. Another factor is that we are unsure how the human immune system will react to the hydrogel."

As soon as that is clarified, the collagen PEDOT:PSS hydrogel could be tested initially on high-risk patients who find the high-energy shocks of the ICDs particularly burdensome.

More information: Kaveh Roshanbinfar et al, Electrically Conductive Collagen-PEDOT:PSS Hydrogel Prevents Post-Infarct Cardiac Arrhythmia and Supports hiPSC-Cardiomyocyte Function, *Advanced Materials* (2024). DOI: 10.1002/adma.202403642

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