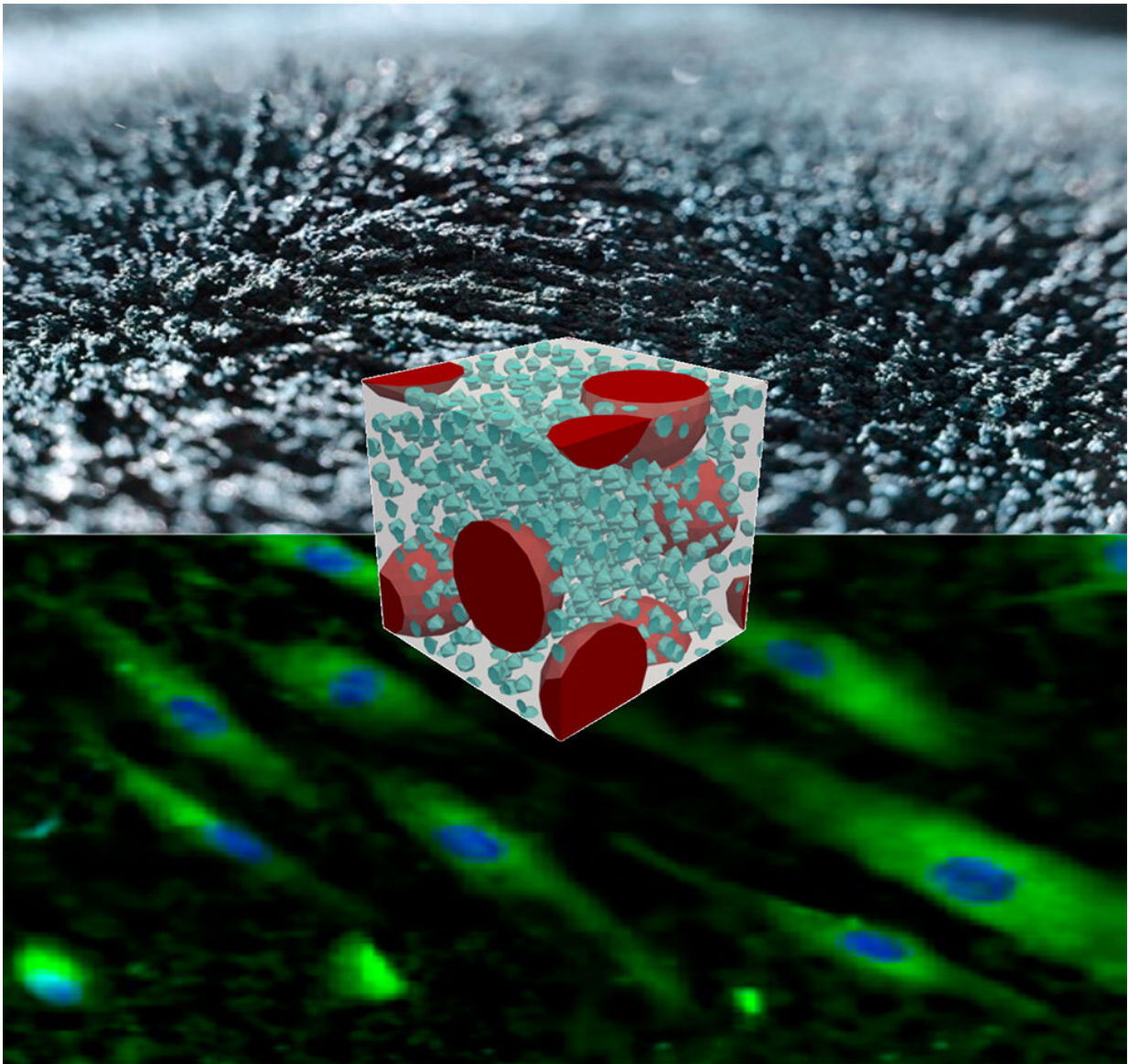


New method to study cellular behavior using smart materials

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The top image shows the forces generated by an external magnetic field on

particles embedded in the material. These interactions are simulated by a computational model that is able to guide the manufacturing and experimental process (middle image). Finally, the generated forces are transmitted to the cells cultured on the smart material (bottom image). This action on the cells will lead to changes or activation of their biological functions, such as proliferation, migration or orientation, among others. Credit: Carlos III University of Madrid

Scientists from 4D-BIOMAP, an ERC research project at the Universidad Carlos III de Madrid (UC3M), have developed a new experimental method, based on magneto-active polymers, to study cellular behavior. These compounds, which consist of a polymeric matrix (e.g., an elastomer) containing magnetic particles (e.g., iron), mechanically react by changing their shape and stiffness. This system could be used to study complex scenarios (such as brain trauma, wound healing, etc.) or to influence cellular responses, guiding their functions.

"We have managed to reproduce the local deformations that occur in the brain when it is subjected to an impact. This would make it possible to replicate these cases in the laboratory, analyzing what happens to the cells and how they are damaged in real time. Furthermore, we have validated the system by demonstrating its capacity to transmit forces to the cells and act on them," explains Daniel García González from the UC3M Continuum Mechanics and Structural Analysis Department.

The idea of this project is to be able to carry out studies replicating complex [biological processes](#) through a new virtually assisted experimental system, which allows non-invasive and real-time control of the mechanical environment. Biological cells and tissues are continuously subjected to [mechanical stress](#) from their surrounding substrate, so analyzing and controlling the forces that influence their behavior would be a milestone for the "mechanobiology" community.

The system proposed by 4D-BIOMAP is based on the use of extremely soft magneto-active polymers that mimic the stiffness of biological materials. Thanks to their qualities, magneto-active materials allow researchers to carry out unrestricted monitoring of biological substrates, as the applied mechanical changes during experimentation can be reversible.

"Supported by the [computational model](#), we have used all this [basic science](#) to design a smart actuation system which, coupled to a microscope developed within the ERC, allows us to visualize the cellular response in situ. In this way, we have consolidated a comprehensive framework to stimulate cellular systems with magneto-active smart materials," says Daniel García González. This proposed framework paves the way to understanding the complex "mechanobiological" processes that occur during dynamic deformation states, such as [traumatic brain injury](#), pathological skin scarring or fibrotic remodeling of the heart during a myocardial infarction, for example.

The study is published in *Applied Materials Today*.

More information: Miguel Angel Moreno-Mateos et al, Magneto-mechanical system to reproduce and quantify complex strain patterns in biological materials, *Applied Materials Today* (2022). [DOI: 10.1016/j.apmt.2022.101437](#)

Provided by Carlos III University of Madrid

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