Website address:
https://www.gesundheitsindustrie-bw.de/en/article/press-release/soft-materials-smarter-robots

Soft materials for smarter robots

Soft robots, robot systems made of soft materials, open up new perspectives for medical technology and industry. Jun.-Prof. Dr. Aniket Pal from the University of Stuttgart is conducting research into viscoelastic materials that have the potential to embed intelligent functions in soft robots. He is receiving 1.5 million euros in funding for this research as part of the Emmy Noether Program. The funding period began on September 1, 2025.

“This funding will allow my research group to significantly expand its research,” says Pal. The 33-year-old leads the Soft Robotics Mechanics Group at the Institute of Applied Mechanics. “We are conducting research in a relatively new field; developing mechanisms that deform depending upon the speed of applied forces and making them suitable for use in soft robotics.”

Viscoelastic materials for soft robotics

Unlike conventional robots made of steel, aluminum, or hard plastic, soft robots are made of soft materials. Soft robotic systems rely on specially designed polymers. Aniket Pal`s team specifically focuses on viscoelastic polymers. These materials exhibit both elastic and viscous properties when undergoing deformation; i.e., they behave both like a solid (elastic) and a fluid (viscous), and their mechanical behavior is dependent on both time and the rate of deformation. The speed at which the force is applied determines which behavior dominates: Viscoelastic materials tend to exhibit elastic behavior when loaded quickly, and viscous behavior when loaded slowly. This type of material can be used to make soft robots more functional and intelligent.

“Development involves not only selecting the right material but also designing its geometric structure at the millimeter scale —and understanding the complex interplay between viscoelastic deformation and mechanical instability,” explains Pal. Such purposefully designed structures are known in science as mechanical metamaterials.

Relevant in medicine and industry

Such mechanisms could one day be valuable — for example, as gentle, soft grippers in medical and industrial applications, or even as bone implants. Improved safety helmets could also become possible, as they would be able to absorb a significant amount of energy during a severe impact without causing harm to the wearer.

Once Pal and his team have thoroughly characterized viscoelastic materials through experiments, they plan to release this extensive data set as open source. They also aim to develop analytical and numerical models in order to be able to describe the relevant structures and their behavior.

Aniket Pal's career

Pal studied production engineering in Jadavpur University, India, and completed his doctoral studies at Purdue University, USA. From 2020 to 2023, he worked as a postdoctoral researcher in Prof. Dr. Metin Sitti’s group at the Max Planck Institute for Intelligent Systems in Stuttgart, supported by a Humboldt Research Fellowship. In September 2023, he was appointed as a tenure-track Junior Professor at the University of Stuttgart, where he leads the Soft Robot Mechanics working group. In addition to Bachelor’s and Master’s students, his research group currently includes three doctoral students. This September, another doctoral student joined the team as part of the Emmy Noether funding program. Three more are to follow.

Pal is a faculty member of the International Max Planck Research School for Intelligent Systems (IMPRS-IS), as well as a member of the Stuttgart Center for Simulation Science (SimTech) and the Center for Bionic Intelligence Tübingen Stuttgart (BITS).

The Emmy Noether Program
The Emmy Noether Program of the German Research Foundation (DFG) provides exceptionally qualified young researchers with the opportunity to qualify for a university professorship by independently leading a junior research group for a period of six years.

Aniket Pal on University of Stuttgart's podcast
What if machines could learn from the softness of human skin? In the latest episode of the podcast "Made in Science", Aniket Pal shares insights into his research. Podcast Episode #52 – "Intelligence by design"

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Further information

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