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NRP 62 Project Highlights

Wonder materials for new therapies

Within the scope of the National Research Programme "Smart Materials" (NRP 62), researchers have developed responsive materials and developed new applications, in particular for medical use.

For the past five years, around 100 scientists of NRP 62 have created and used materials that react to their environment by changing their physical properties. Here are a few highlights from the 21 projects of the programme.

New medical devices

Four projects explored the possibility of using smart materials for new medical devices, in particular:

- A team led by Michael de Wild from the FHNW in Muttenz fabricated elastic and highly porous 3D metallic scaffolds as bone substitutes;
- Martin Wolf from the University Hospital Zurich developed a sugar sensor for premature babies.

Focus: Optical glucose sensor for premature babies

"All premature babies have to be tested for glucose to prevent possible cases of hypoglycaemia, which may lead to impaired brain development," explains Martin Wolf, an engineer working at the University Hospital Zurich (USZ). "But it is not possible to regularly draw blood for analysis, as infants are too fragile." His portable glucose sensor can simply be worn on the skin for continuous measurements, as the sugar molecules can diffuse through the permeable baby skin and be quantified in the device.

The tool is based on a new smart membrane developed by Empa in St. Gallen that changes its permeability when illuminated by UV light. This allows the device to take two measurements with different amounts of glucose molecules, which removes the necessity of drawing blood to calibrate the apparatus.

The device is well advanced, says Wolf: "We are in contact with a Japanese medtech company that is thinking of building a research lab in Switzerland. One researcher of my team is planning to create a start-up."

Accurate therapeutical weapons

Six projects focused on targeted drug delivery, where therapeutic molecules are precisely unloaded where and when desired. This reduces both doses and side effects. Four highlights:

- Alke Fink from the Adolphe Merkle Institute in Fribourg created a small vesicle that can release its therapeutic load when heated up by an applied magnetic field;
- Wolfgang Meier from the University of Basel created a nanoreactor: a minute container where two inert components mix to synthetise a drug and deliver it on the spot;
- At the University of Fribourg, Katharina Fromm added chemical sensors to nanoscaled containers of silver ions, an antimicrobial agent, in order to release the drug only in the presence of bacteria;
- A project led by Dominique Pioletti at EPFL developed a new way to activate drugs near damaged cartilage in the knee.

Focus: Targeted drug delivery for the knee

"We developed a new material that can encapsulate the desired drug and release it only when the person is moving," explains Dominique Pioletti, from the Biomechanical Orthopedics Laboratory at EPFL. "This is desired because the targeted cells are only receptive to the drug, a growth factor, when the joint is moving." The drug would be injected directly in the knee via arthroscopy, a minimally invasive procedure.

Pioletti's team created a new hydrogel which becomes more porous when warmed up. This allows the drug molecules to pass through the loosened capsule and reach the cartilage only when the knee is in motion. "We hope to test the procedure in vivo in rodents in the next few years," says Pioletti.

Engineering applications and basic research

A series of projects developed industrial applications, in particular:

- Dragan Damjanovic from EPFL succeeded in developing new piezoelectric materials without lead, a pollutant, for energy-harvesting devices;
- Christoph Weder from the Adolphe Merkle Institute in Fribourg developed materials that soften when wet, a property potentially useful for tyres;
- Researchers from the University of Zurich and Heike Riel from IBM Research in Rüschlikon worked on organometallic materials to develop new kinds of molecular electronics;
- Raffaele Mezzenga from ETH Zurich embedded magnetic nanoparticles in a polymer matrix to fabricate materials that can switch between two shapes when illuminated or heated.

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