SNAPS

Applied MedTech technologies

Quantum sensors

More precise measurements through the detection of the smallest signals and changes as well as high performance - quantum sensors are the hope of new medical application areas. Scientists expect great potential especially in the areas of mobility, healthcare and IoT.

In the future, quantum sensors will be used in medical technology for the diagnosis and early detection of cancer. But what makes quantum sensors so special and unique? Quantum sensors are able to examine the body for free radicals and measure them. Free radicals are often considered indicators of specific diseases. A current research approach is to optimise the conventional MRI procedure using a nanodiamond polariser. The polariser in combination with biomarker molecules, which are injected into the patients shortly before treatment, enables 10,000 times more sensitive and precise imaging.

Another conceivable field of application is a form of painless muscle diagnostics and the control of prostheses based on nerve impulses. In the measurement of muscle signals, quantum sensors offer decisive advantages over measurements using needle electromyography. On the one hand, the measurement can be carried out without any skin contact and on the other hand, it is not painful, whereas it will also be possible for the first time ever to accurately diagnose muscle weaknesses and signals in children.

The basis for accurate diagnostics with the help of quantum sensors is the magnetic field that is created by electrical activity in the muscles. The magnetic signals easily reach the surface of the body, where they can be measured without contact. A new generation of quantum sensors are the so-called optically pumped magnetometers (OPM), which can detect pathological muscle signals precisely and accurately.

RESEARCH PROJECTS TO LOOK AT:

Q-Sens

- **Who?** Researchers from the Universities of Ulm and Stuttgart
- **Partner companies?** Bosch, Zeiss, Trumpf und Bruker
- **What?** High-performance quantum sensors for application in personalised medicine
- **Basis?** Physical basis consists of defects in solids such as diamonds
- **Contact person:** Prof. Dr. Joachim Ankerhold

But how is this possible? Gaseous atoms are integrated into OPMs as sensitive magnetic field probes. By processing the quantum mechanical state of the atoms with laser light, it is possible to read out the effect of the magnetic field using laser spectroscopic methods. Due to the gaseous atoms, no cooling is necessary, so that the OPMs can be very small and flexible.

Basic principle of quantum sensing:

Spin is the rotational motion that electrons perform while simultaneously spinning around themselves like a vortex and flying around the nucleus of the atom. This quantum mechanical movement leads to the creation of a magnetic dipole around the electron. This dipole is subsequently repelled or attracted by other magnetic fields, thereby creating the smallest magnet in the world.