Advances in wireless biosensor technology

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Led by Professor Jukka Lekkala, the Wireless research project is developing miniscule subcutaneous sensors, which can be used to monitor, for example, the function of the heart or prosthetic joints even over long periods of time.

The Academy of Finland is funding the project, whose goal is to provide the more accurate prediction of changes in patient condition and, in turn, even save lives. "For example, a subcutaneous EKG monitor will be able to detect cardiac arrhythmia, and the data for this can then be transmitted wirelessly to the physician's mobile phone or PC," explains Lekkala.

At present patient health status is primarily monitored with supercutaneous sensors. However, wearable and, in particular, implantable, or subcutaneous, biosensors will provide significant advantages over more conventional methods. The biggest problem with conventional measuring systems is poor skin sensor contact. In subcutaneous measuring systems the sensor-to-body contact is more stable. Furthermore, external electrical interference of the measurement signal is reduced, which improves the measurement result. Health care costs are saved, when monitoring is not time and place-dependent: patients will no longer have to make an appointment with the physician for a consultation or tests. Patients under remote supervision can continue living their normal lives for a longer period of time.

This new technology also makes possible measurements and long-term monitoring, which would be practically impossible using existing

technologies. For example, the condition of a prosthetic hip joint can now only be monitored using expensive x-ray imaging-based methods.

Subcutaneous biosensors must not cause problems for the patient

The Wireless research project is also producing new data on the design of subcutaneous biosensors. These should be as small as possible. The integration of electronics and development of packaging technologies make it possible to manufacture sensors and electronics on a silicon chip no bigger than a fingernail. Due to its light weight and small size several of these types of chips can be implanted in a sizable area. The sensors might also contain various microsensors, measurement electronics and wireless communication circuits.

In addition to the small size, the packaging is also challenged by the environment into which it is placed. The Wireless research project is developing sensors and technologies which pose no risk to the patient's health. "The work is extremely challenging, because the electronics have to work reliably for long periods of time under the skin, in a moist, corrosive environment, and they must not pose any health hazards, even if the protective coating were to be damaged for some reason," explains Lekkala.

Advances in biomaterial technologies allow the biocompatible coatings of sensors to be customised for each application. It is even possible to incorporate functional elements, such as by enhancing the implant coating with a layer that releases antibiotics. Sensors should also be flexible, so that they can follow the patient's movements. This requires that the sensor circuit boards are flexible and its components are thin enough to bend with the circuit board. A silicon chip reduced to a thickness of less than 0.1 millimetre will be flexible. When this flexible

package is coated with a thin, protective and biocompatible material, the entire unit will effectively flex with and withstand the patient's movements while implanted.

Wireless combines electronics, biomaterials and health research

The Wireless research project exploits the know-how of experts from five different fields. In Finland this pioneering group unites experts in physiological modelling, biomaterial technologies, biosensors, wireless communications and electronics packaging technologies. The sensors, which are being developed in Tampere, are expected to be used in major medical, social and commercial application. The project is part of the Academy of Finland Future Electronics (TULE) Research Programme.

Source: Academy of Finland