# Microscale medical sensors inserted under skin can be powered wirelessly by external handheld receiver

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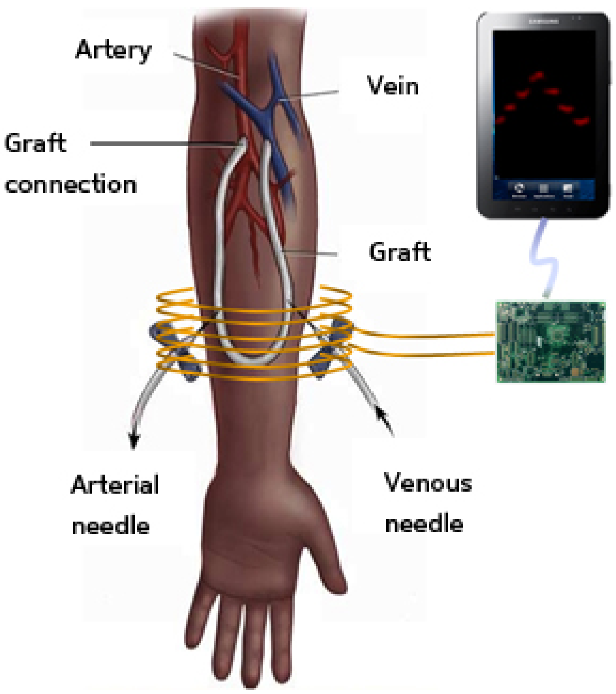


A handheld reader (top right) wirelessly powers and interrogates a tiny blood-pressure sensor embedded inside a prosthetic graft, inserted in this case as a conduit for haemodialysis in a patient with kidney failure. Credit: 2013 A*STAR Institute of Microelectronics

Implantable electronic devices potentially offer a rapid and accurate way for doctors to monitor patients with particular medical conditions. Yet powering such devices remains a fundamental challenge: batteries are bulky and eventually need recharging or replacing. Jia Hao Cheong at the A*STAR Institute for Microelectronics, Singapore, and his co-workers are developing an alternative approach that eliminates the need for a battery. Their miniature devices are based on wireless power-transfer technology.

The research team has developed a microscale electronic sensor to monitor blood flow through artificial blood vessels. Surgeons use these prosthetic grafts to bypass diseased or clogged blood vessels in patients experiencing restricted blood supply, for example. Over time, however, the graft can also become blocked. To avoid complete failure, blood flow through the graft must be monitored regularly, but existing techniques are slow and costly.

These limitations prompted the researchers to develop a bench-top prototype of a device that could be incorporated inside a graft to monitor blood flow. The implant is powered by a handheld external reader, which uses inductive coupling to wirelessly transfer energy, a technology similar to that found in the latest wireless-charging mobile phones. The team developed an application-specific, integrated circuit for the implant designed for low power use (see image).

The incoming energy powers circuits in the device that control sensors based on silicon nanowires. This material is piezoresistive: as blood flows over the sensor the associated mechanical stresses induce a measurable increase in electrical resistance, proportional to the flow pressure.

Key to the success of the device is its ability to work with a very limited power supply. Most of the incoming energy is absorbed by skin and tissue before it can reach the implant, which may be inserted up to 50 millimeters deep.

"Our flow sensor system achieves an ultra-low power consumption of 12.6 microwatts," Cheong says. For example, the sensor transmits its data to the handheld reader passively, by backscattering some of the incoming energy. "We have tested our system with 50-millimeter-thick tissue between the external coil and implantable coil, and it successfully extracted the pressure data from the implantable device," he adds.

Cheong and his co-workers' tests showed that the prototype sensor was also highly pressure sensitive, providing pressure readings with a resolution of 0.17 pounds per square inch (1,172 pascals). "The next step of the project is to integrate the system and embed it inside a graft for [an experimental] animal," Cheong says.

**More information:** Cheong, J. et al. An inductively powered implantable blood flow sensor microsystem for vascular grafts. *IEEE Transactions on Biomedical Engineering* 59, 2466–2475 (2012). dx.doi.org/%2010.1109/TBME.2012.2203131

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