Smart implants

R&D fact sheet

Today's medical implants are advanced and highly-specialized systems. Nevertheless, they rely on rather traditional design and integration technologies. The use of advanced integration technologies, developed for ICT (information and communication technology) applications, would enable a strong miniaturization of the implants and the addition of on-board intelligence, all contributing to the vision of an individualized proactive health-care. Low-power design methodologies deployed to implantable devices will furthermore increase the autonomy of the implantable systems. Because of its strong expertise in ICT packaging and integration technologies, IMEC is ideally placed to translate this knowhow to the field of implantable systems.

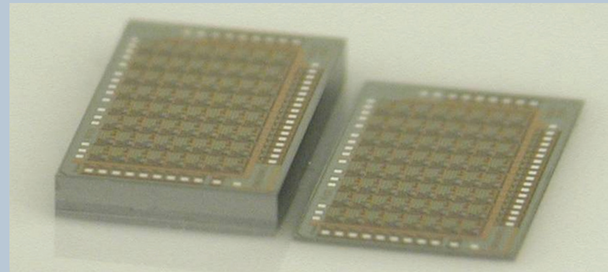
The goal of this smart-implants research program is threefold:

- *Make the package disappear*
  IMEC investigates solutions in the field of ultra-thin-chip-stacking, ultra-thin-chip-in-flex and chip-in-wire technologies as breakthrough alternatives to the traditional system-in-a-package technologies that are used today for smart implant devices. Furthermore, as not all systems benefit from thin flexible solutions, a unique out-of-plane 3D integration is developed e.g. for neuronal probes (to be used for example for deep-brain stimulation).

- *Provide hermetic, bio-tolerable sealing*
  Improving the tolerability implants by the body is a key requirement for long-term reliable operation and for reducing adverse reactions. Additionally, the harsh character of the living organism calls for special measures to avoid curtailing implant reliability. A combination of strategies involving surface modification and coating technologies is developed at IMEC, supported by its extensive expertise in MEMS encapsulation and reliability.

- *Balance the power budget*
  The low-power demands for wearable health monitoring systems are very stringent and even more for implantable systems due to the reduced volume available. Ultra-low power design imposes architectural solutions to sensor front-ends, analog-to-digital converters, signal processors, wireless communication and power management building blocks. Moreover, energy scavenging techniques may prove to be very valuable for autonomous implants.

- *Wireless capability*
  The quest for autonomy also includes the need to communicate wirelessly with the outside world. More information can be found in IMEC's leaflet on wearable health and comfort monitoring.



Chip thinning of complex functional circuits down to 15 micrometers for use in smart implants.

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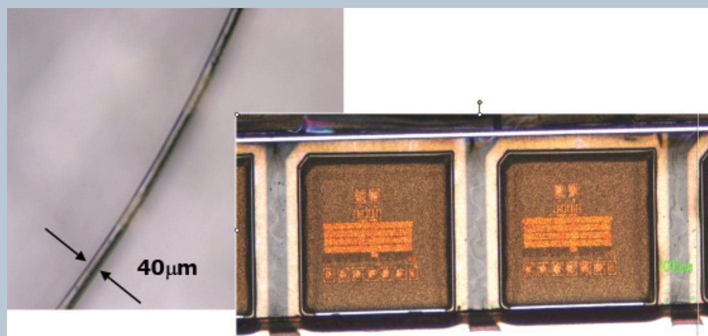
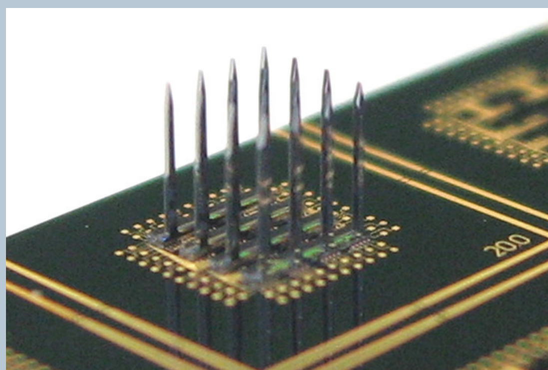
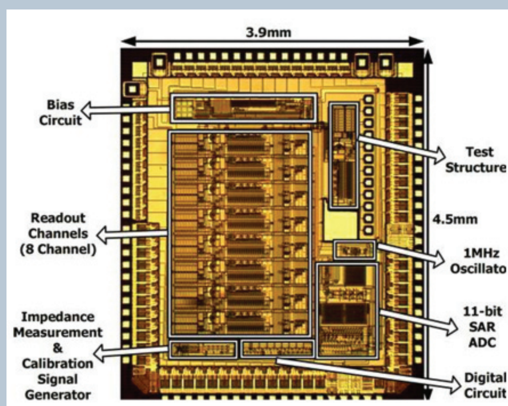


Chip-in-wire technology with the embedding of active chips for applications such as cochlear implants.



Unique out-of-plane 3D integration technology for probe arrays.



Custom biopotential circuitry for ExG applications.

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