Last year, a project team from the group of Gerjan van de Walle and DTS (Devices, Technology & Services) transferred a fully MOS-compatible passive-integration process to Philips Semiconductors Caen. All technical conditions have now been fulfilled to enable the production of high-density storage capacitors.

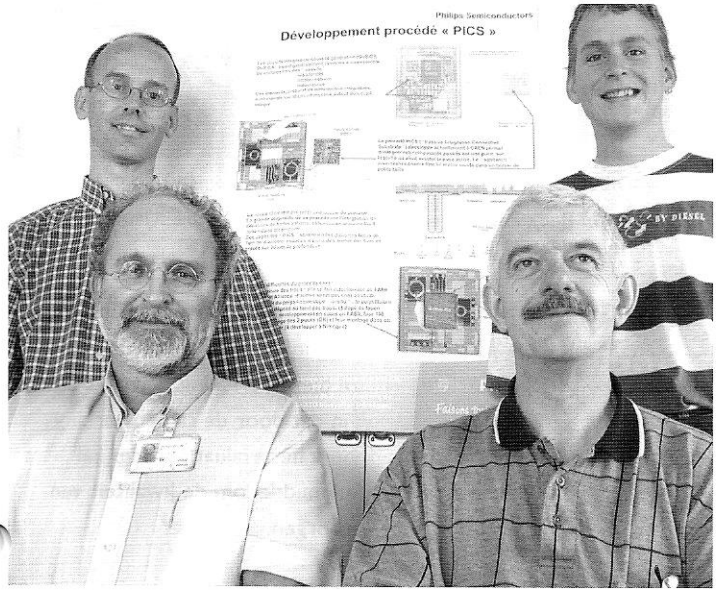
Highlight

High-density capacitors for production

The PICS1 (Passive Integration Common Substrate) process, with EXSTC (EXtreme STorage Capacitor) as an example, involves the manufacturing of integrated passive components, including the high-density EXSTC trench-based MOS decoupling capacitors in porous silicon with capacitance densities from 30 to 60 nF/mm^2. Recently, Philips Semiconductors (PS) Caen passed the milestone of process approval for manufacturing. Volume production will start end 2003, after completing the procedures related to the release for production.

Motivation

The EXSTC project started in 1997 in the group of Gerjan van de Walle, as part of the work on passive integration. It was aimed at developing robust high-density decoupling capacitors with full MOS compatibility and thus with high potential for integration in Philips' existing silicon-based manufacturing, packaging and product range. Also the integration of inductors and resistors was studied for integrated output power-matching units in wireless communication, leading to an earlier transfer of the so-called PASSI process. This process base has now been extended with the EXSTCs to the PICS1 process. There has been a close cooperation with PS Caen and PS Nijmegen for the realization of demonstrators.



EXSTC team active in passive integration; from left to right: Eric van den Heuvel, Fred Roozeboom, Jan Verhoeven and Anton Kemmeren

Products

The first products containing the integrated EXSTCs were launched last June by PS at the Bluetooth Expo in Amsterdam. The BGY 102 'plug and play' radio module, containing integrated passive and active components in a conventional ultra-small (6 x 6 mm^2) HVQFN package, was shown as the first product of a large variety of Bluetooth RF modules, all within Philips' new *System-in-Package* concept. Applications are manifold in wireless communication and digital signal processing (e.g. in RF supply-line decoupling and phase-locked loop filtering), markets where PS is or can be a major player.

People involved

The EXSTC team members at the Nat.Lab. are Anton Kemmeren and project leader Fred Roozeboom from the Van de Walle group, and Jan Verhoeven and Eric van den Heuvel from DTS. Continuous support was given by Frans Holthuysen (scanning electron microscopy) and Hans Kretschman (electrical testing), both from DTS. Earlier contributions have come from René Elfrink (Philips Optical Disc Technology Centre), Theo Rijks and Jan van den Meerakker (Van de Walle group). The project has continuously been enriched with national projects and European cooperation projects, with partners such as TU Delft, Alcatel, QinetiQ, STS, Analog Devices, Olivetti and VTT, where focus was on anisotropic silicon etching and silicon micromachining.

Prospects

The project has now entered the next stage, focusing on further miniaturization and increasing of the capacitance density and interconnection. New partners have been found, both within Philips (Centre for Industrial Technology) and outside. Spin-off applications have further been found, e.g. in *silicon nanowire* application (cooperation with Utrecht University), optical waveguide (*photonic bandgap*) structures (Twente University) and sensors.

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