Role and Strategy of IMEC as a European Player in a Globalized Research Era

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1. Introduction

IMEC was established in 1984 to perform research in ICT that runs 3 to 10 years ahead of industrial needs. Today, IMEC stands out as Europe's leading independent research center in the field of microelectronics, nanotechnology, enabling design methods and technologies for ICT systems. IMEC has a staff of more than 1250 people, including over 380 industrial residents and guest researchers. Its revenue (presently exceeding 140 Meuro) is derived from its frame agreement with Flanders' government, and from contracts with equipment and material suppliers, semiconductor and system-oriented companies, as well as from projects with the European Commission, MEDEA+, and the European Space Agency. IMEC collaborates with more than 450 companies and institutes worldwide and has set up about 20 spin-off companies.

2. IMEC's research

The R&D activities are subdivided into 3 broad domains.

Silicon Process and Device Technology

IMEC develops process steps and modules required for advanced CMOS technologies, concentrating on the 65 and 45nm technology generations, but already exploring sub-45nm devices. Strategic research programs have been set up in optical lithography (193nm and 157nm), high-k dielectrics and novel gate stack materials, copper and low-k interconnects, ultra-clean processing, silicides, ultra-shallow junctions and wafer-level packaging. Several CMOS options are being pursued including BiCMOS, nonvolatile memories and analog/RF CMOS. Novel silicon devices making use of strained silicon, SiGe and SOI are also explored. Supportive disciplines such as component and material physics, physical simulation, physical and electrical characterization, reliability and yield, form an important part of these activities. Most of the R&D is carried out in IMEC's state-ofthe-art clean room, which includes a 200mm pilot line. Early 2003, IMEC started the construction of a 300mm research facility which

will allow to perform world-class research on the most advanced process steps, materials and devices for the sub-45nm CMOS nodes.

Microsystems, components and packaging

A major part of this activity is directed towards the development of the "Ambient Intelligence" society or "smart environment". IMEC has set up two programs to deal with the specific requirements for ambient intelligence: M4 and Human++. The M4 program will bridge the gap between microelectronics and complex system design in order to exploit the most advanced components for the realization of multi-mode multi-media terminals at low cost and with low power consumption. In its Human++ program, IMEC combines micro- and nanofabrication for improving the quality of life. The roadmap includes point-of-care units for diagnostics based on advanced proteomics and distributed sensor networks for health and comfort monitoring. Most of the new systems will consist of several components integrated into one single package (systems-in-a-package or SiP). IMEC uses this approach in the development of RF-SiPs, optical detectors and bioSiPs. Other enabling technologies include: high-density interconnections and packaging, spintronics, plastic electronics, advanced solar cells and novel energy harvesting methods. These activities are also part of IMEC's interface with the nanotechnology world. Convergence between the top-down and bottom-up methods will give birth to novel IC technologies with potential advantages in cost, performance and functionality.

Design technology for integrated information & communication systems

This domain covers the design and integration aspects of the M4 and Human++ programs. IMEC has built up considerable expertise in critical competencies, such as wireless communications, ambient multimedia, design technology, and reconfigurable systems. Within the M4 program, IMEC is extending its strategy to further combine and integrate these research activities. This program focuses on bridging the gap between microelectronics and complex system design for the realization of a multi-mode multimedia terminal. Within the Human++ program, IMEC's design technology experts build the necessary know-how at the system level: wireless communication in and around the human body, ad-hoc networking of wireless nodes, and design technology for a fast reproducible design cycle. IMEC also develops several methods to support power-efficient design optimization. First, task concurrency management (TCM) minimizes the average power consumption as a function of the actual load of the system. Concurrently, data transfer and storage exploration (DTSE) improves the energy efficiency of applications by reducing the energy needed for accessing data in memory. DTSE is supported by the IMEC ATOMIUM tool suite, which allows a thorough analysis and memory organization exploration of real-life applications in limited design time.

3. Industrial strategy and business model

IMEC's interaction with industry favors R&D partnerships based on IP sharing in the framework of a program-driven approach. The IMEC Industrial Affiliation Program (IIAP) scheme has demonstrated excellent adequacy to industrial needs, provided that (a) the research program has a generic character, addressing pressing problems for a broader range of companies, and (b) the research is situated early enough in the technology life-cycle to allow for each participating industrial partner to build its own - often product-oriented - differentiator afterwards (fig. 1). Industrial contracts are essentially bilateral, with IMEC as the common platform. This allows each industrial partner to join a program within its own best fitted timing, thus avoiding situations where all partners have to sign-up jointly. Although most of the more generic results, based upon existing background information of the research platform, are being considered as 'co-owned without any accounting to each other', some complementary results which are more company specific can also be defined. The latter are the exclusive ownership of the industrial partner. The above mechanism vields strong leveraging effects, such as: (i) sharing of cost and infrastructure, (ii) early access, leading to a time-to-market advantage compared to non-participating parties, (iii) crossfertilization by combining complementary companies, (iv) build-up of critical mass through a team of industrial residents, (v) re-usability of which also allows a close IP results

collaboration with the other industrial parties at a later stage.

At the local level, IMEC's INVOMEC division is in charge of stimulating transfer of know-how and industrial applications of research towards the Flemish industry (with a focus on the Flemish SMEs). This mission is accomplished by achieving process and product innovation in existing companies or by the commercialization of research results via the creation of new spinoff companies. INVOMEC has also a standing role in dedicated (hands-on) training programs , both for local and international industrial trainees as well as for academia.



Fig 1. Technology lifecycle and positioning of IMEC activities.

4. Conclusion: IMEC's role in future semiconductor R&D

At this moment, the challenge for the major semiconductor R&D players is to "develop leading nanoelectronics research in the 300 mm era". As an important actor in this field, IMEC will support such needs through its proven strategy and business model. This implies:

building the infrastructure that will allow nanoelectronics device and processing R&D to be performed on state-of-the-art equipment. In many cases, this will require the installation of 300mm-compatible tools;

establishing efficient channels to transfer information and expertise to the industrial partners. Based on past experience, the IMEC business model has proved to be an excellent instrument to effectively generate this flow of knowledge in a timely and cost-effective way;

mobilizing the research community, in particular the academic groups, and providing the means that will allow them to contribute substantially to the progress of semiconductor technology and the fostering of talent.