The New AMS 200 mm Mixed Signal Foundry – Technical and Economic Challenge

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1. Introduction

During the last years the traditional vertical business model of the semiconductor industry has undergone many changes, and new models have evolved. The different levels of value creation in the industry have been mapped to individual companies specializing in different aspects of the semiconductor value chain. Fabless design houses could be easily established, as the high entry barriers in form of the high capital needs of an integrated company did not apply any more. Others specialized in various production tasks as mask shops, test, and assembly plants and pure play silicon foundries. Those who remained "fabbed" as new vertical semiconductor companies started to control the different value creation steps on an individual basis and such became able to benchmark themselves against the specialists in the market. This trend has strongly improved the overall efficiency of the industry and has created a large number of new semiconductor companies, many of them are very successful on the market and achieved high valuations on the stock markets.

2. New Strategy of *Austria Mikro Systeme*

About three years ago *Austria Mikro Systeme International* also had to find an answer to the question for a new strategy. It had to be decided whether to remain a vertical integrated semiconductor company with all consequences or to adopt the new fabless model. Because of its traditional strengths in production including a very high quality and reliability record demonstrated in aviation, automotive, and industrial applications, AMS selected to remain fabbed. In addition, a certain part of the production volume was and is subcontracted to foundry partners which have AMS processes implemented. Today AMS still offers all aspects of semiconductor development and production as a "one-stop-shop", but has separated the responsibilities into individual business units. In order to measure the performance of each unit against the best in class in the world, three product oriented business units (Automotive, Communications and Industry) and a production unit (Full service foundry) have been created.

Focusing on markets, customers and special application segments got high attention, at the same time the new 200 mm wafer fab project for deep sub micron technologies was started. Key reasons for the decision to undertake this major investment of 300 MEuro into the new fab have been on the one hand the need for access to state of the art technologies in the deep sub micron range. This includes the possibility to implement AMS specialties as BiCMOS, SiGe and HV (high voltage) on top of those. The capacity requirements of dynamic markets of the customers as well as the need for an improved

cost structure have been additional reasons. The whole project is structured in a way which allows to achieve a world wide competitive position for the production.

3. The *Austria Mikro Systeme* 200 mm Mixed Signal Foundry

The 200-mm Fab is set up as a three level SMIF (standard mechanical interface) fab with a cleanroom of class 1.000 on a waffle table of 2.600 m² and an additional cleanroom area of 1.100 m². Meanwhile it has been proven that the vibration characteristics of the building will allow to process even very advanced technologies down to 0,13 µm structures, the overall capacity will be > 2.500 WSPW (wafer starts per week), this roughly quadruples the production capacity.

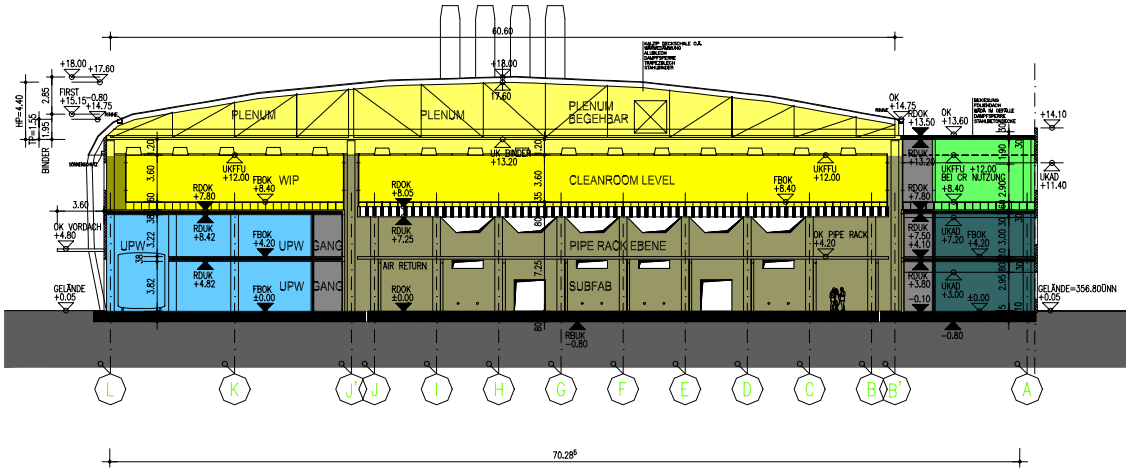

Fig. 1: Cross section of 200 mm Fab. The dark yellow (medium gray) section indicates the cleanroom area for production.

The fab will be equipped with most advanced SMIF and mini environment techniques (better than class 1) and will differentiate itself by flexibility and special process modules added on top of the base CMOS processes. These process options target high performance mixed signal and RF circuits (BiCMOS and SiGe-BiCMOS) as well as systems on chip including sensor elements (e.g. micro mechanical elements for accelerometers and hall effect sensors for various applications). For automotive and industrial applications a range of high voltage technologies are available which are exactly tailored to the existing and future business of the respective customers.

Examples for successful products using this technological base include car access systems, safety critical data transmission, and sensor applications in automotive applications as well as metering, control circuits, and bus systems in the industrial environment. For voice and data communications the RF-technologies are used for low power/ high speed applications in the wired and wireless world.

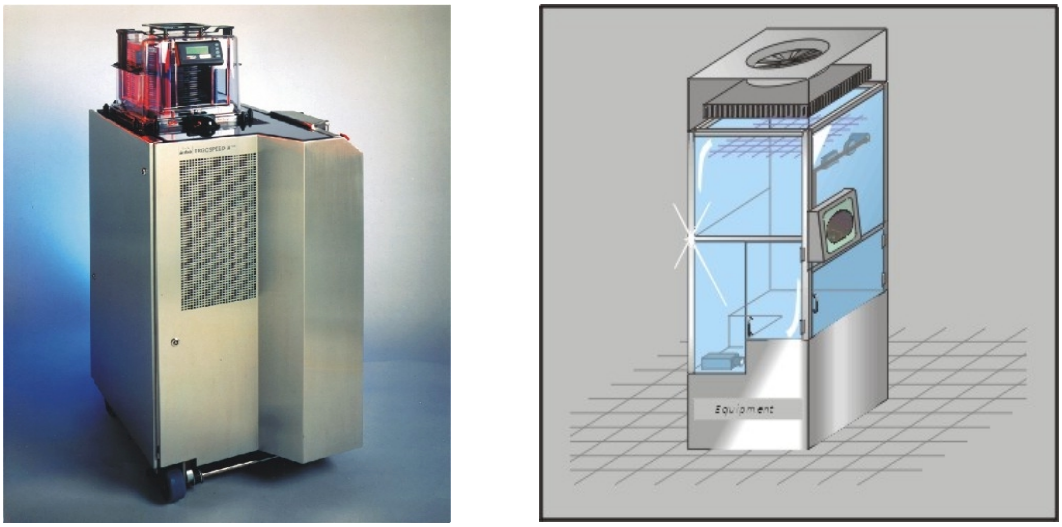

Fig. 2: SMIF robot with wafers loaded in a pod (left) and view of a ME (mini environment) which is supported from the top.

4. Technological Capabilities for the Future

In defining the technology roadmap of a semiconductor company the product portfolio and the markets served have a significant influence. In times where DRAMs and high performance processors already start to use 0,13 µm CMOS technologies produced on 300 mm wafers, other market segments can still be served well by technologies in the range of 0,6 µm to 0,25 µm. Depending on the amount of analog content of a mixed signal chip, a very advanced deep sub micron technology may even not make business sense at all.

As the products of the future tend to incorporate more and more diverse functions (analog, digital, sensors, memory, NV-memory, MEMs) the set of technologies has to respond to this SoC (system on chip) trend. There is still a tradeoff to be found between integrating all functions on one chip (pure SoC solution) or combining two or more chips in a package (system in package approach), which in some cases might be the more economic one. *Austria Mikro Systeme* is committed to a technology roadmap shown in Fig. 3, which still shows several specialized technologies in 0,8 and 0,6 µm needed for high volume business with long term commitments for automotive and industrial customers. 0,35 µm mixed signal CMOS including the BiCMOS and SiGe options will be the last true 5 V technology and the first entry point in the system level design. For BiCMOS f_t (f_{max}) of 30 (30) GHz will be available, for the SiGe Option the respective figures are 55 (75) GHz. The technologies are designed as add-ons to the CMOS base process, so a complex digital part (4+ layers of metal) can be combined with analog and RF functions. Whereas CMOS will become the mainstream technology for applications up to a range of 2 – 5 GHz, SiGe HBTs will generate a major competition for GaAs circuits in the frequency range up to 30 – 40 GHz.

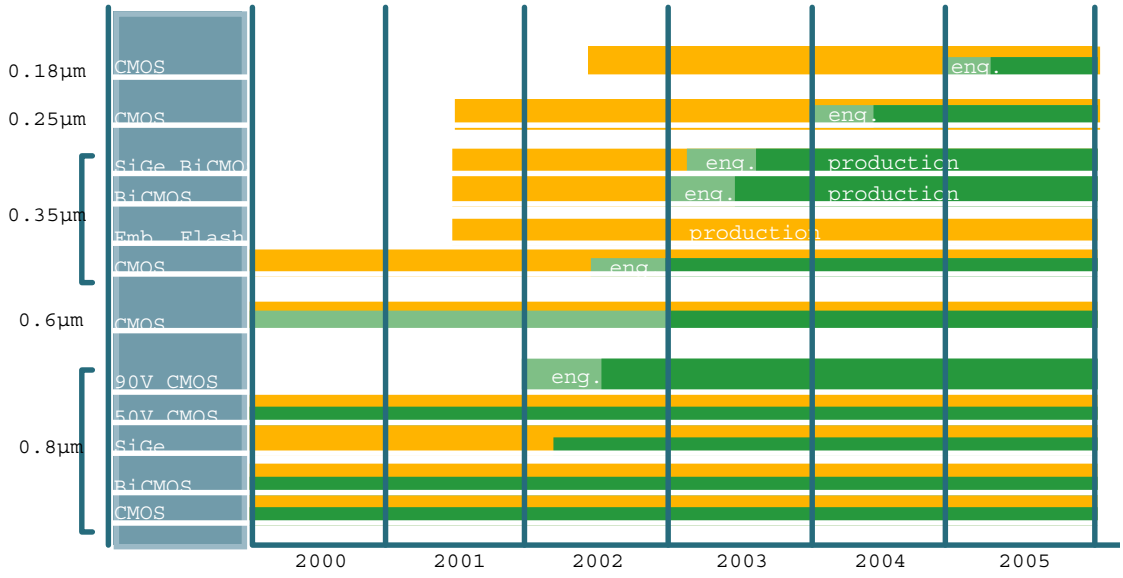

Fig. 3: Technology Roadmap: green (dark gray) indicates production at AMS foundry, yellow (light gray) shows contracted production at partner foundries in AMS processes.

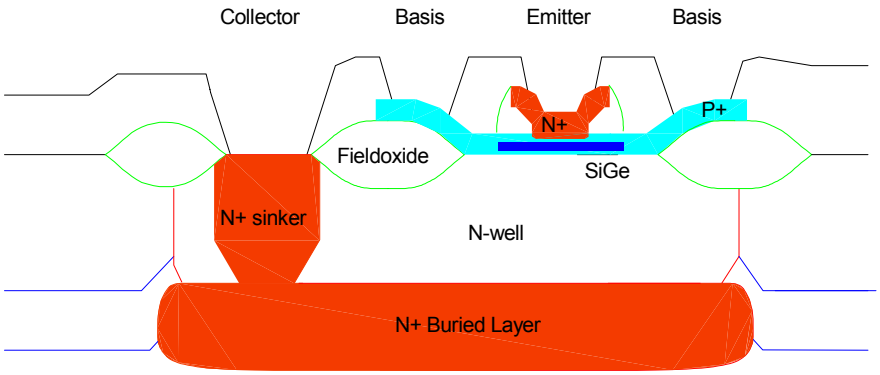

Fig. 4: Schematic cross section of a SiGe-HBT with two base contacts.

5. Summary

Having adopted the appropriate business model of individual product and production oriented business units, a mid-sized vertical semiconductor company can be successful. The individual units have to be compared to the best in class on a regular basis, and continuous learning has to be applied. It is possible to invest into state of the art production facilities and achieve a worldwide competitive cost structure even with a moderate sized fab. For a successful position on the foundry market it is necessary to offer special process enhancements, as mixed signal and RF as well as sensors and MEMs. These offers must not be restricted to the process but have to be combined with a flexible support in modeling, parameters and design support as well as support in debugging and migration to a volume production scenario.