



ANNUAL REPORT 2002

SINGULUS 



S U C C E S S

WITH SUPERIOR PRODUCTS...

... AND A SUPERIOR

S T R A T E G Y



SINGULUS OPTICAL DISC MACHINES



SINGULUS GOES MRAM





→ **SINGULUS OPTICAL DISC MACHINES**

→ **SKYLINE**

Expansion of our line business began with the SKYLINE CD replication line in 1996 and led to the attainment of our global lead in the marketplace. Since that time our customers have purchased over 1300 machines which are used for all prerecorded CD formats.

→ **SKYLINE DUPLEX**

The Duplex compounded the market success of the SKYLINE CD replication system. Its combined CD/DVD 5 application garnered market share for the company all over the world.

→ **SPACELINE**

In 2002, sales were realized for 182 SPACELINES. With over 400 lines in operation, the SPACELINE has become the most frequently sold system for DVD replication.

→ **SPACELINE SACD**

In September 2002, a new SACD (Super Audio CD) replication line for super audio hybrid discs was introduced to the market. It is modeled on the successful DVD SPACELINE yet can also be used for DVD production.

→ **STREAMLINE CD-R**

Today, the CD-R STREAMLINE is one of the most reliable systems on the market.

→ **STREAMLINE DVDR/SP**

The Spaceline metallizing and bonding modules were combined to form the basic system in the STREAMLINE for the new DVD-R growth format.

→ **MODULUS**


The modular design of the MODULUS RW metallizer comprises the core component of our RW replication line.

→ **SUNLINE**

In the fall of 2002, the new SUNLINE RW became the first replication line certified for DVD+RW by PHILIPS to manufacture rewritable DVDs in production. SINGULUS thus became the first systems manufacturer in the world to receive certification for DVD+RW production on a machine operating in fully automatic mode.






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- **SINGULUS EMOULD INJECTION MOLDING MACHINES**  
EMOULD performance exceeds expectations: In 2002 SINGULUS EMOULD GmbH manufactured over 250 machines. The reliability and performance of these machines is valued the world over. EMOULD machines are suitable for all prerecorded, recordable and re-recordable CD and DVD formats.
- **SINGULUS OMP MASTERING SYSTEMS**  
In 2002, SINGULUS OMP enhanced its successful DMS 8000 system and in January 2003, introduced the DMS Evolution, the first mastering system designed specifically for DVD formats.
- **SINGULUS V**  
The SINGULUS V metallizer was successfully established in the market following its launch in 2001.

## OPTICAL DISC TECHNOLOGY


### CD-TECHNOLOGY: Storage Capacity approx. 650 MB

Prerecorded Information	Recordable	Rewritable
 <b>CD, CD-ROM</b> Read Only Memory ROM	 <b>CD-R</b> Write Once Read Many WORM	 <b>CD-RW</b> Write-Erase-ReWrite RW or RAM

### DVD-TECHNOLOGY: Storage Capacity max. 9,4 GB (18 GB)

Prerecorded Information	Recordable	Rewritable
 <b>DVD-Video, DVD-ROM</b> Read Only Memory ROM	 <b>DVD±R</b> Write Once Read Many WORM	 <b>DVD±RW, DVD-RAM</b> Write-Erase-ReWrite RW or RAM

### DVR-TECHNOLOGY (Blu-Ray): Storage Capacity 27 GB (2 x 25 GB)

Prerecorded Information	Recordable	Rewritable
 Read Only Memory ROM	 Write Once Read Many WORM	 Write-Erase-ReWrite RW or RAM

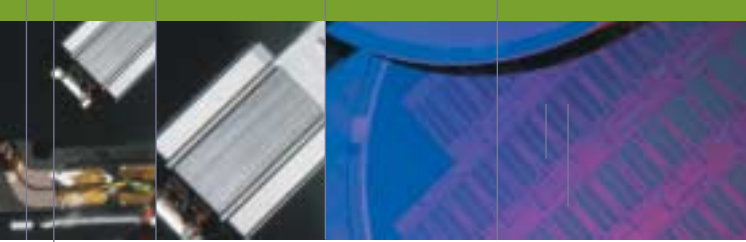


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**STREAMLINE  
DVDRISP**

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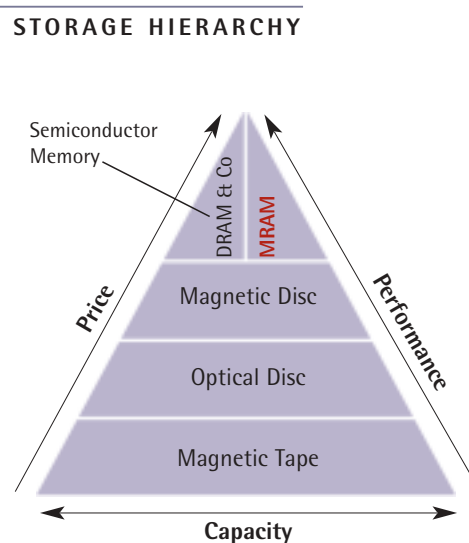


## → SINGULUS GOES MRAM

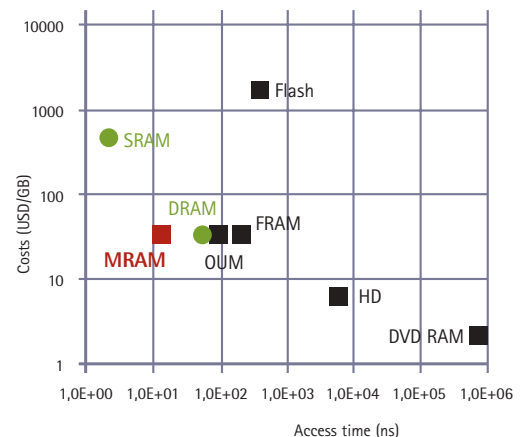
### INITIAL ADVANCE INTO A NEW FIELD OF APPLICATION FOR VACUUM DEPOSITION MACHINES

On March 27, 2002, SINGULUS TECHNOLOGIES AG formally announced the expansion of its business endeavors to include the new field of vacuum thin film deposition systems for TMR technology. Such systems are prerequisites for manufacturing semiconductor elements, more precisely termed „MRAM storage media“, and new elements in read/write heads for hard disc drives (magnetic heads). Industry experts believe that MRAM storage media will largely become technical successor to the DRAM standard which now dominates the market. Due to its retention of storage content after power is disconnected and a two- to three-fold reduction in energy consumption, this storage media is extremely attractive, particularly for wireless applications. What opportunities does this market offer SINGULUS?

Kahl am Main, March 2003. Over a year has passed since this project was officially launched. An assessment of this ambitious project proves favorable: the 20-person TMR technology development team completed the TIMARIS prototype thin film deposition system during the year in report.



### COMPARISON OF STORAGE MEDIA (Status 7/02)



The milestones set at the beginning of the year have all been achieved. As of the first quarter 2003, this system has applied sample layers to silicon wafers for either MRAM chips or the new TMR thin film heads for magnetic hard disc drives. Thin film deposition technology is one of many key technologies that will ultimately provide solutions superior to those provided by existing storage formats and thin film read/write heads.

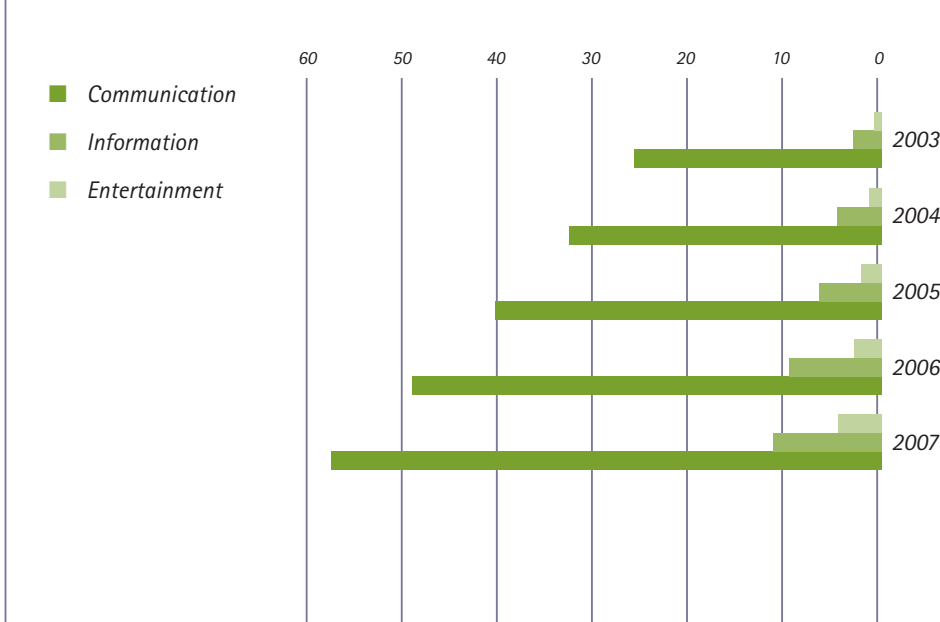
→ **TMR TECHNOLOGY FOR HARD DISC DRIVE READ/WRITE HEADS (MAGNETIC HEADS)**

Personal computers (PCs) have changed drastically during the last decade. They have become significantly faster and more powerful. This is not only the result of the increased speed and power of processors, but also due to the improved performance of storage technology.

Storage densities were increased in 1990, particularly on hard drives. In 1996/97 this process received another boost, principally from a leap in technology resulting from the use of new elements in the so-called read/write heads of hard drive systems. These heads not only read but write the information stored on hard drives.

The element employed since 1990 was based on the so-called AMR effect (AMR=anisotropic magneto resistance). The element employed since 1996/97 is based on the so-called GMR effect (GMR= giant magneto resistance). These two physical effects became the foundation for the fundamental innovations in hard drive

**SALES EXPECTATIONS WITH MOBILE DATA SERVICES (in Billion US\$)**



Source: FAZ, 17.02.03  
Ovum, 2003



technology during the past 15 years. They were the primary reason for the growing business in the hard disc industry. Magnetic storage media (hard drives) were able to assert and expand their exceptional role in the development of PCs through the AMR and later GMR processes. Today they are still the most efficient storage media for this field of application.

#### > THE FUTURE OF HARD DISC DRIVES HAS A NAME: TMR

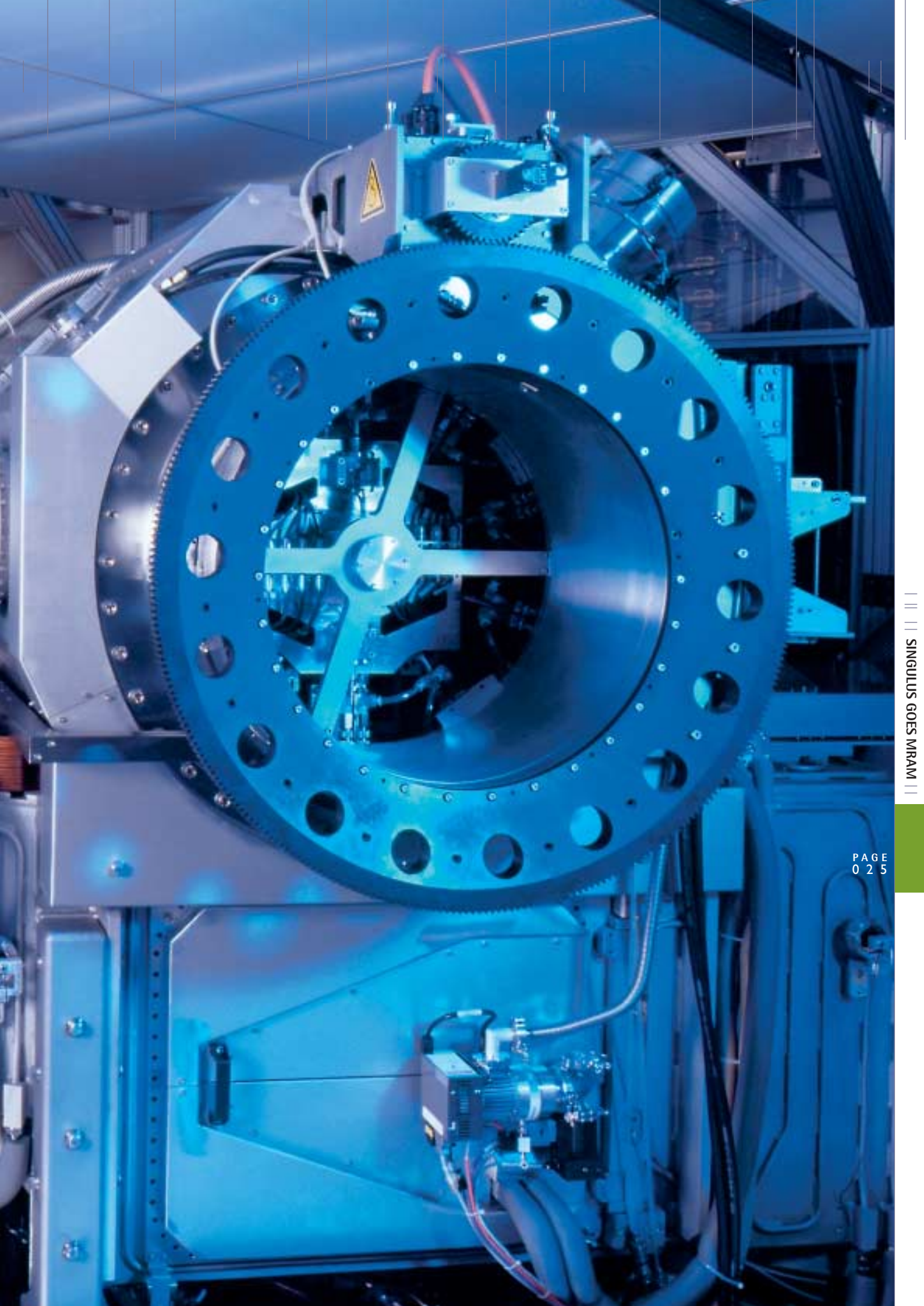
Virtually all hard drive manufacturers (and hence potential TIMARIS vacuum thin film deposition machine customers) agree that the next generation of read/write elements will be based on the TMR effect. The explosion in hard drive performance cannot arrive too soon. The introduction of hard drives to consumer electronics (i.e., used for buffer storage in time delay TV, for interim storage of broadcasts during parallel reception, perhaps even for downloading film data from the internet, etc.) leads to expectations for a tremendous increase in demand for high-performance hard drives. Private film archives have high storage requirements. This segment of the market will drive hard drive storage densities in the terrabyte per square inch realm (Tbit/inch<sup>2</sup>) and promises further growth in this industry.

SINGULUS will help create the ensuing market for vacuum thin film deposition machines for TMR-based read/write elements and actively participate in its growth. The high-end deposition technology required will be a challenge to the core competence of the engineers in Kahl am Main.

#### → TWO VISIONS, ONE CORE TECHNOLOGY

High tech vacuum deposition is one of the most important key technologies for the advancement of performance parameters in the IT world. When layer thicknesses approach the realm of less than a micrometer, it is also referred to as „nanotechnology“.

What does „universal semiconductor storage media“ mean? Among its characteristics, existing semiconductor memory still has either the disadvantage of losing information as soon as its electrical power source is removed (DRAM, SRAM, Flash), or is extremely slow (Flash). The universal semiconductor storage of the future should be non-volatile and extremely fast, yet consume less energy, achieve storage densities comparable to DRAM, and naturally cost no more than established solid state memory. In short: an effort is being made to “square the circle”.





At present, the most promising storage technology is offered by the so-called MRAM (magnetic random access memory) wafer based on the TMR effect. Approximately 30 semiconductor companies around the world are currently engaged in the development of this technology, including most major companies such as Infineon, Micron, Motorola, Samsung, NEC and others.

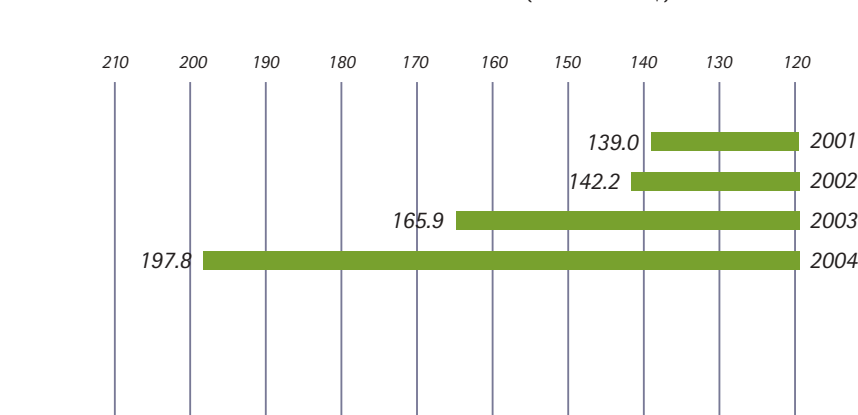
While semiconductor components have thus far been produced only on silicon substrates with a maximum diameter of 200 mm, MRAM chips will be produced on 300 mm diameter substrates (so-called Si wafers) in the future, although 200 mm MRAM wafers will presumably still be produced initially. Machines for 300 mm diameter wafers operate much more cost effectively than 200 mm machines since the substrate surface (and consequently the chip quantity) is nearly double.

The costs per wafer i.e., chip, must be minimized. This lead to an economic need to obtain a high yield of chips per wafer which in turn leads to extremely high demands for uniformity of the applied layers and productivity of the deposition systems employed in MRAM applications.

→ **NEW FROM THE OUTSET**

The TIMARIS conceived by SINGULUS was specifically designed for the semiconductor industry from the outset. It does not resort to older machine concepts but is instead „tailor-made“ for this application. All drafted requirements were taken into consideration during the design phase. The TIMARIS has shown exceptional results based on all tests conducted thus far.

**SEMICONDUCTOR MARKET FORECAST** (in Billion US\$)



Source:  
World Semiconductor  
Trade Statistics, 10/2002

How extensive is this market? The utilization of new storage in wireless electronic devices (cell phones, notebooks, hand-held PCs) is attractive because energy consumption has been drastically reduced and usable wireless time can be extended. As soon as MRAM storage technology can be cost effectively mass produced, a strong demand could ensue in the market.

The market development rate for new technologies is by its nature difficult to assess. However, SINGULUS maintains that in the years ahead, new investments in thin film deposition machines will number in the tens of millions of Euros and even in the hundreds of millions by 2005. SINGULUS intends to capture a significant portion of this market. While competitors have the advantage of a better-established customer base in the semiconductor industry, the SINGULUS engineers in Kahl consider themselves more technically advanced.

