valled productivity, is still at an early stage of development. However, first printed systems are available on the market and the fabrication of higher-performance products is foreseeable.

References

[1] C. R. Newman, et al., "Introduction to Organic Thin Film Transistors and Design of n-Channel Organic Semiconductors", Chem. Mater. 16, 4436 (2004).
[2] J. Veres et al., "Low-k Insulators as the Choice of Dielectrics in Organic Field-Effect Transistors" Adv. Func. Mater. 13, 199–204 (2003).
[3] PolyIC, "Pre-eminent innovation from Germany: Electronic products out of the printing machine draw nearer", Press Release, December 2, 2005.
[4] Philips, "Philips demonstrates world-first technical feasibility of 13.56-MHz RFID tags based on plastic electronics", Press Release, February 6, 2006.
[5] A.C. Huebler et al., in preparation (2006).
F. Doetz et. al., "Fully Mass Printed Integrated Circuits", MRS Fall Meeting, Boston (2005).

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MNT Needs Methodologies and Software Tools

Andrew Richardson, Patric Salomon and Ayman El-Fatatry

Micro and nanotechnologies are enabling multi-functionality across a wide range of systems-centric applications; a capability that is unique to these technologies. At the core of such systems is the seamless interaction between physical and functional domains. Current design methodologies and tools are, within this context, limited and will need to evolve to reflect the complexity and holistic nature of the end systems. Thus improvements of design methodologies and associated software tools will be an important contribution to the commercial success of MNT-based systems.

A number of European and National initiatives have been launched to co-ordinate work on design, modelling and simulation methodologies and initiate their implementation into tools, coordinate between users and suppliers, disseminate information and stimulate public support:

NEXUS, the European Microsystems Association, had launched their Methodology Working Group "Design Modelling Simulation (MWG DMS)" in early 2000 to implement these tasks on a European level. The NEXUS MWG DMS has been successful through contributing to the NEXUS roadmaps published in 2001 and 2003 and in helping to launch the EC funded Network of Excellence on "Design for Micro & Nano Manufacture (PATENT-DfMM)" in 2004. Recent meetings have usually been co-organised by NEXUS and PATENT-DfMM.

In Germany, a "Working Group: MST Design Methodologies (Arbeitskreis MST Entwurfstechniken)" was launched in 2001 to initiate coordination between small and large companies, universities, Fraunhofer and other research institutes. Workshops have been held to coordinate between stakeholders with strategy papers and new ideas for funding mechanisms finding their way into the German government programmes. Furthermore the group was able to improve exploitation of results from R&D projects through their co-ordinated approach.

The UK MNT Network launched a "Design Modelling & Simulation Focus Group (DSMfg)" in 2005. With the vision that MNT is providing the basis of an increasingly integrated platform for multi-functionality and interoperability, modelling and simulation tools need to be able to operate across many domains to enable designers to produce systems-based products and services. Based on the above vision, DSMfg debates requirements and potential solutions associated with such a challenge. One example would be that the Focus Group may help provide a framework and an approach to integrate techniques and tools (a framework where tools could plug in), a process for bridging concurrent models and for, at best, classifying a hierarchy of models.
One also needs to look at the increasing emphasis on rapid prototyping as a means of accelerating development timescales for products and systems. Underpinning such capabilities are design, modelling and simulation tools which enable users to assess, in "real-time", concepts and options for a variety of complex products. Rapid prototyping for MNT will be delivered through the integration of such tools within the fabrication processes.

How realistic and how soon is the "screen-to-product scenario" in the MNT world? What do software tool providers regard as the major challenges? A few sentences taken from interviews:

For the industrial and semiconductor market segments, having a design methodology in place as opposed to none can make a huge difference in success. MEMS/MST companies are facing the same situation. In order to put such a methodology in place, Coventor's Josephus van Kuijk requests companies "to pay more attention to CAD tools, give them more value, and explore what is available today and discover that technical capabilities of MEMS/MST software tools are already beyond what most companies think is possible."

"From the modelling point of view the most important challenges to address are those tools supporting multiphysics, multiscale and multirate simulations", notes Sakari Lukkarinen from Comsol. "That means that several phenomena at different abstraction levels shall be coupled including several time scales in simulations."

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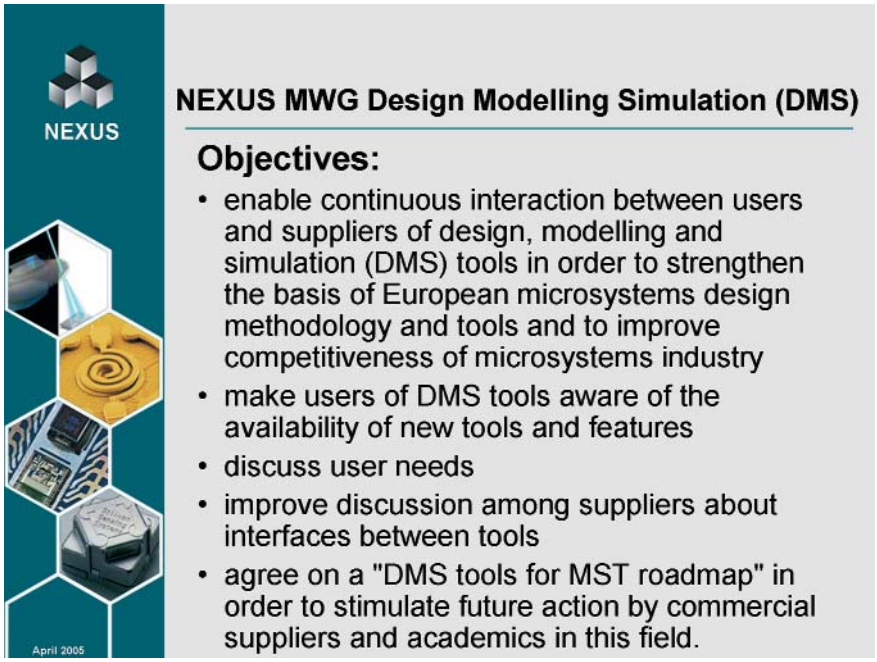

Fig. 1: Objectives of the NEXUS MWG "Design Modelling Simulation (DMS)"

Ridha Hamza from SoftMEMS agrees that main emphasis needs to be put on MEMS modelling at the behavioural level, quoting its advantages "it allows an optimisation and statistical analysis of MEMS devices behaviour and ensures a full system simulation at an early stage of the design, allowing considerable gains in productivity".

Sometimes users have unrealistic expectations as far as simulation is concerned. "Some users expect that all effects can be predicted by simulation, but they often don't consider the fact that simulation is based on models. All effects to be handled by a certain model have to be known already when developing the model", says Andreas Hössinger from Silvaco.

Improved design support is becoming a key commercial requirement with pressure on tool vendors to optimise models aimed at providing the designer with the means to predict the impact of second-order effects on the design (e.g. package-induced stress and mode coupling), and verify end-use stability and subsequent reliability, especially in aggressive environments.

Many typical applications of micro & nano system technologies require very high reliability, and suitable test methodologies, standards and instrumentation are often missing. Time-to-market targets for most MNT products will therefore only be achieved if these so called "back-end" issues are addressed early in the design cycle. The Network of Excellence in "Design for Micro & Nano Manufacture (PATENT-DfMM)" has the mission to establish a collaborative team to provide European industry with support in the field of DfMM with a view to ensuring that problems affecting the manufacturing and reliability of products based on MNT can be addressed before prototyping and production. The project aims to initiate integration and growth in DfMM skills and capability with the long-term objective to set up a financially sustainable organisation that provides a DfMM service to European Industry.

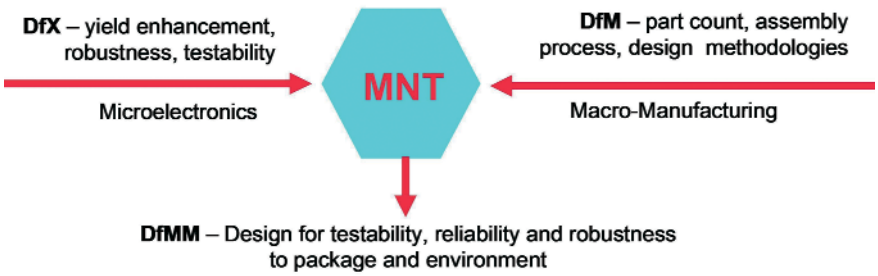

Figure 2: The PATENT project's approach to DfMM

PATENT-DfMM is closely co-operating with international networks and initiatives such as NEXUS, the UK MNT Network and MEMS Industry Group in the US. With united efforts these groups will have the power to set standards, drive international co-operation between vendors and users and initiate joint actions between research and industry to establish methodologies and tools that are needed to improve robustness and maturity of Micro Nano Technologies.

Acknowledgement
This article is based on information from current activities of the NEXUS and UK MNT Design Modelling Simulation focus groups, the EC network of Excellence 'PATENT-DfMM' and interviews with key software providers in the areas of MNT design, modelling and simulation.

More information is available from the following websites:
- www.patent-dfmm.org
- www.microandnanotech.info
- www.nexus-mems.com
- www.comsol.com
- www.coventor.com
- www.silvaco.com
- www.softmems.com

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