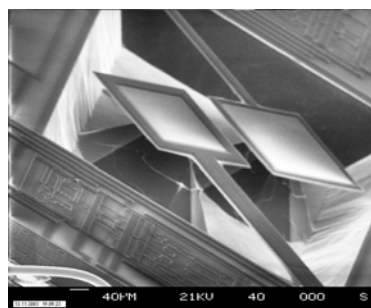




## Lowering the barriers to commercialisation for the next generation of micro and nano technology based products

*A European 6<sup>th</sup> Framework Network of Excellence building a new technical community to support European industry in the process of designing manufacturable micro & nano technology based products*

The concept of extending processes used within the microelectronics industry to fabricate moving parts with feature sizes in the  $\mu\text{m}$  scale has stimulated innovation associated with sensing and actuation technology, control of optical signals and the manipulation of extremely small quantities of fluids. Recently, processes have emerged capable of realising these micro components in glass, polymers and metals in addition to silicon. Applications across a wide range of industrial sectors from the bio-medical and pharmaceutical industries to transport have been proposed. State-of-the-art is now at a point where multiple technologies can be integrated into extremely compact systems that utilise materials and structures engineered at the nanometer scale. It is also possible to mix fluidics, optics and electronics on single substrate carriers.



*Applications targeted include a range of MEMS structures and systems that embed MEMS as core functions.  
Photo courtesy of LIRMM*

These advances are impressive but successful products are still limited. One of the primary reasons for this is that the feature sizes and complexity of micro & nano technology based systems normally translate into major difficulties in guaranteeing stability, robustness and associated reliability within the target working environment.

The PATENT-DfMM project was built from an increasing degree of synergy in the experience of both academics and industrialists working on test and reliability issues, modelling technology and the integration, packaging and assembly processes. It became clear that if the design cycle and associated tools could be enhanced to allow designers to explore reliability and testability issues early in the design process and predict the impact of package, assembly and the external environment on the micro & nano scale structures, design iterations and manufacturing costs could be reduced. Furthermore, the ability to model interactions between the micro & nano world and the product environment together with an understanding of the ageing, degradation and failure modes within the devices and materials would allow reliability to be better predicted and improved.

19 research laboratories and 3 companies have created this Network of Excellence that is coordinated by Lancaster University, UK. The consortium includes the national research centres IMEC, Belgium, Tyndall National Institute, Cork, CNRS-Toulouse, France, IMT Bucharest, CEA-LETI, France and CCLRC, UK, the Industrial research centres Fraunhofer IZM (Berlin and Munich) and IMS, Dresden and university research laboratories, Heriot Watt University, University of Montpellier (LIRMM), Polytechnic of Milan, Budapest University of Technology, IXL, Bordeaux, University of Bremen, Catholic University of Leuven, MESA+, Twente, and Warsaw University of Technology. The industrial partners include an

end user, Qinetiq UK, training provider, ISLI, UK and a marketing company, 4M2C. The project is monitored by an Industrial Advisory Board consisting of 20 companies that includes EDA providers (Coventor, Dolphin Integration and SoftMEMS), equipment manufacturers (SUSS MicroTec AG, National Physical Laboratory, MicRed and DELTA), and both fabrication facilities and system integrators (ST Microelectronics, BAE Systems, Colibrys, Bosch, Infineon, IMEGO, Oxley Developments, Protron, TRW, C2V, MicroCircuit Engineering, EnablingM3 and ESA).

As of January 2006, over 60 activities have been launched under the project framework to improve integration, generate new collaborative intellectual property through joint research, secure commercialisation routes for key services and establish the team as a key international cluster. Activities in the 1<sup>st</sup> 12 months mainly targeted improved integration within the 4 Virtual Laboratories, the second 12 months has however seen more cross laboratory activities. In 2005 there has been 121 separate publications released of which 1 has been a patent, 17 have been referred journal papers (12 published, 5 in–press) and 43 refereed conference and international workshop papers. The rest are newsletters, promotional articles in magazines like MST news. At the end of this 2<sup>nd</sup> year, 21 separate items of exploitable output have been identified that will form the input into the 2006 market test process. Selected areas of value have been selected through a peer review process to form input to 3 flagship projects in 2006 (1. Design for Manufacture of Integrated Bio-MEMS, 2. Reliability of Integrated MEMS and 3. MEMS for Health and Usage Monitoring Applications)

In the area of Test Integration, a 4 institute cluster has been established with skills in motionless testing of moving structures such as inertial sensors. New techniques have been developed based on bias modulation and a proof of concept demonstrated fabricated (fig. 1). A bio-sensor test cluster has also been developed with novel techniques published collaboratively. Work is now targeting drug

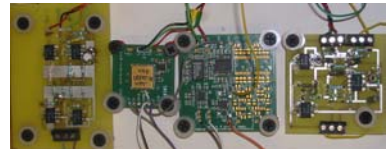


Fig. 1 : Demonstrator to prove the capability of bias superposition as a test strategy for a MEMS accelerometer

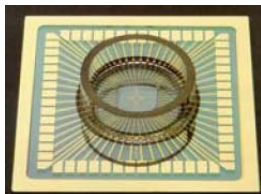


Fig. 2 : Drug discovery platform - underpinning fluidic technology for Bio-MEMS activity. Courtesy - QinetiQ

discovery platforms based on a droplet transport technique (Fig. 2). In this area work is now merging with modelling activities that over the past 18 months has been focusing on fault and fault free modelling of droplet transport technology.

In addition to the above, modelling and simulation work that focuses on design for manufacturing has been closely tied into the packaging activity. Studies have looked into Electro-magnetic coupling into MEMS structures, modelling of damping mechanisms / package environment in moving MEMS structures and enhanced stiction modelling in switches. A program of test structure fabrication and characterisation is also active to characterise new parameterisable behavioural models for better prediction of prototype behaviour and fault effects. A major study that involves both modelling and test structure characterisation is now active that aims to fully understand and capture the impact of the most important package structures and adhesives on encapsulated MEMS devices.

Database development has been active across the test, reliability and packaging domains. Initial content has been generated that covers material properties, failure mechanisms, instrumentation availability and packaging solutions. New test structures are currently under development and the characterisation work above will generate further data for this database. Initial plans to make this database commercially available do not appear feasible from an initial market study as revenue would be unlikely to cover the cost of maintenance. This database will hence form an internal resource for the NoE to support consultancy with industrial customers.

Training development has secured core IPR that forms key material for tutorials, CPD courses and for a future masters. Tutorials in thermal engineering and failure analysis have been delivered and been well accepted. The first 3 day course in Package Modelling & Analysis was delivered at IEF in December and the Distance Learning course in Modelling Technology to support MEMS manufacture is almost complete. There are a number of additional modules under development that includes test engineering and training that pulls together technology, management and societal issues. Two summer schools have been successfully run each attracting between 30 and 40 delegates.

Interfacing the NoE to the commercial environment has received much attention. A portfolio of skills, services and exploitable IPR has been developed and a market test process initiated. A number of potential business models have been assessed for future delivery of the teams knowledge and resource to the industrial community. The NoE has taken leadership of the Reliability and Test MWG within NEXUS and 3 out of the 5 new steering committee members of NEXUS are from the PATENT-DfMM NoE. This guarantees a strong pull from the NEXUS association for industrial access to PATENT-DfMM resources and optimal promotion of these resources.

### **Plans for 2006 / 2007**

Within the first two years of the project, multi-disciplinary distributed teams have been established who are willing to deliver services to industry in collaboration. Critical mass in each of the 4 key disciplines have been established with numerous activities crossing the conventional discipline boundaries. An initial portfolio of services, skills and IPR has been compiled. 2006 will see the team putting most resource into 3 flagship projects that include:

1. Design for Manufacture of Integrated Bio-MEMS platforms,
2. Reliability of Integrated MEMS that embraces clusters in acceleration factors, package reliability and harsh environments and
3. MEMS for Health and Usage Monitoring Applications.

These projects will focus the NoE resources and skills into activities that will generate case studies to demonstrate competence and capability within the technical clusters offering industrial services. Further focus will be established through testing the market for DfMM services.

More information:

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