



## Y2 Review Meeting Overview of Reliability" Flagship Projects,

Orla Slattery, Tyndall National Institute

May-06

«Design for Micro & Nano Manufacture (NoE PATENT-DfMM)»  
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### Presentation Outline

Network of Excellence «Design for Micro & Nano Manufacture (NoE PATENT-DfMM)»  
PATENT-DfMM Reliability Flagship – Nexus MWG Meeting Stresa, April 2006

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May-06 Slide 2


- Background to the Reliability Flagship Projects
- Brief Overview of activities
  - VIBSHOCK
  - HERMETICITY
  - RELMETH
  - ACCELEROMETERExample of Some Common Activities: Modelling and Reliability Tests
- Strategy for Co-ordination of Common Activities
- Key Deliverables
- Budget
- Impact and Self-Sustainability
- Summary and Current Status



## Background

Network of Excellence «Design for Micro & Nano Manufacture (NoE PATENT-DfMM)» [www.patent-dfmm.org](http://www.patent-dfmm.org)  
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- The concept for "Flagship" demonstrator project first discussed at in May 2005
- Initial themes/draft suggestions presented to PATENT-DfMM partners in October 2005 with input from the test engineering activity
- Draft ideas/themes presented at Assembly meeting in November 2005 with IAB and reviewers. Feedback highlighted that Reliability Methodologies of significant importance to industry.
- 6 EoI relating to reliability activities evaluated by MB & IAB chair, December 2005
- Reliability Flagship accepted with 4 components - Feb 2006



## The "Reliability" flagship projects

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- 4 projects addressing DfMM (Test, Modelling, Characterisation, Reliability and Packaging) for specific application spaces
- Microsensor for Humidity and Hermeticity (HERMETICITY)
- Vibration and Shock for MEMS in Harsh Conditions (VIBSHOCK)
- Methodology for Accelerated Testing and Reliability Analysis (RELMETH)
- Low Cost Accelerometer, Testable, Reliable, Low Cost (ACCELEROMETER)
- The projects include 17 of the NoE partners, a high level of collaboration has already been demonstrated
- All of these areas are critical for successful demonstration of DfMM
- Industrial interest is very strong - 5 industrial partners are contributing to these projects; ST Microelectronics, Philips Semiconductors, Sintef, C2V and QinetiQ



## Brief Overview - VIBSHOCK

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**Title:** Holistic Reliability Engineering for MEMS in harsh conditions

**Project duration:** March 2006–June 2007, Phase 1 (Mar/06-Nov/06), Phase 2 (Dec/06-Jun/07)

**Partners:** 10 partners with expertise in harsh environment testing, modeling, packaging and material analysis  
IMS, IMEC, CSL, Polimi, Tyndall, BUTE, HWU, WUT, IMT, IZM

**Industrial partners:** Sintef (samples provider and active contribution to FWP3 and FWP6), C2V (samples provider), ST (samples provider), Qinetiq (samples provider)




## Brief Overview - VIBSHOCK

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**Project outline:** Reliability issues for MEMS can only reasonably be tackled in a holistic way including package engineering, failure mode modeling and test methodology. This is especially true for MEMS in harsh conditions where sometime packaging is even more prone to failure than the MEMS device itself.



**Objectives:**

- Setup of test equipments for reliability testing under harsh conditions and conduction of test (e.g. temperature cycling with temperature up to 350 °C, strong vibration, impacts,...)
- Package engineering including modeling of package effect on MEMS device (e.g. development of a package model of the device under test, investigation of packaging materials like die attach etc. in use, ...)
- Multi-domain failure mode modeling and definition of new test methodologies (i.e. investigation of failure modes of the package and of the MEMS device and their cross-link resulting in a better insight of the failure mechanism allowing for the definition of a new test methodology in harsh condition)


 Brief Overview HERMETICITY


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*"Integrated Characterisation of Packaging  
 Hermeticity, Combining, Test, Modelling, Reliability  
 Characterisation and Packaging Integration of a  
 Humidity Microsensor"*

Partners  
 Tyndall, IXL, IEF, LAAS, LIRMM, QinetiQ, BUTE,  
 IMT, POLIMI, CEA-LETI

Industrial Partner  
 Philips Semiconductors




 Brief Overview HERMETICITY

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Objectives


1. Use a humidity microsensor as a device to demonstrate DfMM
2. To design, fabricate and test a humidity microsensor to electrically detect traces of humidity
3. To analyse reliability and packaging concerns for wafer level packaging
4. To identify the reliability measurement and modelling challenges associated with humidity, hermeticity and WLP
5. To define mechanisms for bringing together partner knowledge and expertise gained within the first 2 years of the NoE to demonstrate DfMM via a specific demonstrator of direct industrial benefit

 **Brief Overview HERMETICITY**

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### Humidity Microsensor


- Based on nanoporous silicon with high specific surface to electrically detect traces of humidity. Apply porous silicon technology on SOI wafers or on integrated passive component substrates, IEF-UPS and IXL
- In-situ investigation, intended for WLP, but may also be used for other packages
- Philips Semiconductors, French Research Centre, to supply consumables

 **Brief Overview - RELMETH**

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### Task F1.2. "*Methodology for accelerated testing and reliability analysis of MEMS – RELMETH*"

- Aim: to prepare the NoE Patent-DfMM for solving, by a one-stop-shop approach, the customer requirements on **MEMS accelerated testing and reliability analysis**.
- Partners from **4 WPs**: WP1 (LIRMM); WP2 (IMT, CSL, ULAN); WP3 (IMT, POLIMI, BUTE, CSL, IMS); WP4 (IMS, CSL, HWU)
- Tool for investigation: the **reliability analysis**.
- Goals: i) **to assess** the reliability level of a batch of MEMS, ii) **to improve** the batch reliability by proposing appropriate corrective actions (in design, processes, monitors, etc.) and iii) **to build** prediction methods able to foresee the reliability of future batches from the same device.
- Eventually, a **reliability methodology** (RELMETH) will be developed, covering most situations encountered in these reliability analyses. With the aid of an adequate IAB feedback, RELMETH might become a valuable instrument for fulfilling the reliability requirements from industry.




## Brief Overview - RELMETH

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**DESCRIPTION:**

- RELMETH develops results of finished or running Patent-DfMM projects.
- Duration: 15 months (April 2006-June 2007).
- First phase (- November 2006): the accelerated tests and reliability analyses on **one type of MEMS (accelerometer)** supplied by ST Microelectronics.
- Second phase (- June 2007): accelerated test & reliability analyses on the **sensor for hermeticity manufactured by the project HERMETICITY**, from the same cluster.
- An **offer on reliability for industry and research** will be elaborated (first version in June 2006).
- The results will be **disseminated** on Patent-DfMM webpage and by papers in „mst news“, „MNT Bulletin“, etc., in the frame of the sub-project on common actions.
- In November 2006, a first version of a **course** on "Accelerated testing and Reliability analysis" will be delivered to the training coordinator. This version will be up-dated in June 2007.



## Brief Overview - ACCELEROMETER

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- Activity builds on previous work within PATENT on QinetiQ accelerometers/ SOI processes (WPs 1-4)
  - Workshops held in 2006
    - aim to establish, and cost, extra work required in 2007 to complete the demonstrator activity
  - Small precursor study on reliable low cost packaging of SOI accelerometer devices. including conventional CLCC (as a reference), Chip on Board and Wafer level
    - packaged samples prepared
    - initial reliability screening
      - simple failure analysis as required.
- Deliverables
  - A detailed resourced/ costed plan for the proposed demonstrator activity for consideration as part of the call process for 2007 activities -M35
  - A report on possible low cost packaging options for SOI accelerometer devices - M35
- Practical demonstration of PATENT-DfMM network working
  - All technical workpackages working together

**DfMM**  
NoE PATENT

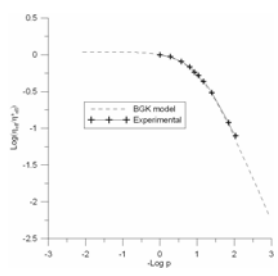
### Examples of Some Common Activities RELMETH & VIBSHOCK Modelling

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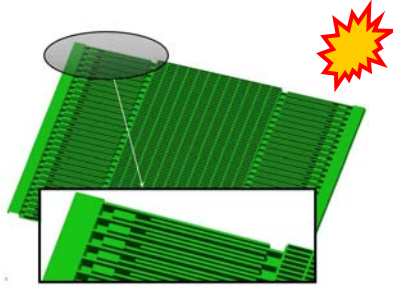
**Main Industrial partner:** ST-Microelectronics (samples provider). Tri-axial accelerometers.



**Main activities:** responsible of modeling of vibration, shock and damping effects; design of test structures for on-chip mechanical characterization; collection of new experimental data concerning rupture of polysilicon.



POLIMI  
DAMPING  
MODELLING




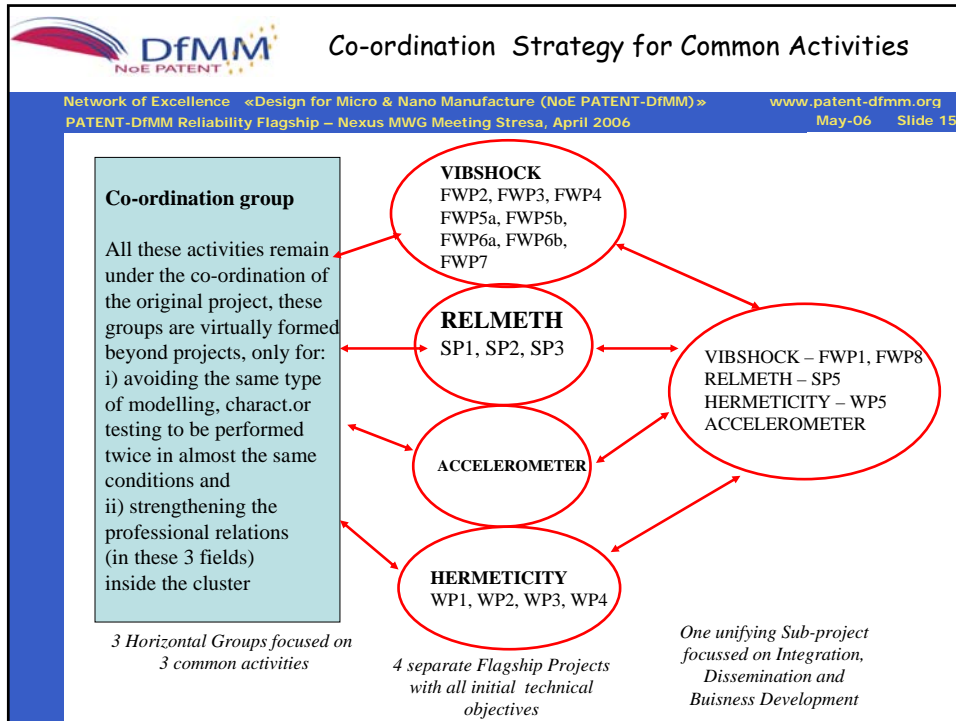
**DfMM**  
NoE PATENT

### Examples of Some Common Activities ST Test Structures for RELMETH & VIBSHOCK


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- Test structures to be used by both projects have been given by ST Microelectronics
- MEMS Inertial Sensors: 3 Axis +/- 2g +/- 6g linear accelerometers
- Samples have been given to Alberto Corigliano and will be distributed to project partners 28/03/2006 at coordination group kick-off meeting in IMEC
- Test plans to be finalised at kick-off meeting





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- DfMM**  
NoE PATENT
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- Co-ordination Group**
- The project leaders for the individual projects are;  
RELMETH - Marius Bazu (IMT)  
VIBSHOCK - Khiem Trieu (IMS) and Ingrid de Wolf (IMEC)  
HERMETICITY - Claude Pellet, IXL and Orla Slattery (Tyndall)  
ACCELEROMETER - Alan Brown, QinetiQ
  - These 6 project leaders, along with Alberto Corigliano, will form the co-ordination group
  - Kick-off meeting of this group 28/03/2006 at IMEC
  - Distribute ST test structures
  - Formulate Test Plans
  - Formulate modelling and simulation plans
  - Discuss details for packaging requirements
  - Finalise budgetary issues
  - Plan meeting and dissemination schedule



## Key Deliverables, 1


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**VIBSHOCK**

- Report on determined data from missing materials and effects of harsh environment stimuli on the materials (M35) and update (M39)
- Equipment setup for high temperature and vibration/shock testing completed (M31)
- Experimental and Modelled Results for High Temperature and Vibration/shock (M35) and update (M40)
- New reliability test methods (M41)
- Service for reliability engineering of MEMS in harsh conditions (M43)

**ACCELEROMETER**

- Report on Low cost packaging solutions for SOI accelerometer devices (M35)
- Proposal for 2007 demonstrator project (M35)



## Key Deliverables, 2


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**RELMETH**

- Report with results of accelerated tests & reliability analyses on ST Microelectronics MEMS devices (M35)
- Course on accelerated tests & reliability analysis for MEMS (M35)
- Report with results of accelerated tests & reliability analyses on the sensor for hermeticity manufactured by HERMETICITY (M41)
- Report comparing the state of the art vs. Patent-DfMM knowledge in accelerated tests & reliability analysis (M35, 41)

**HERMETICITY**


- MEMS test structure for hermeticity (M33)
- Benchmarked models for assessment of environmental effects on reliability of packaged MEMS (M36)
- Methodology for Measurement of Effects of Hermeticity and Humidity on MEMS (M36)
- Modelling Training - Best Practice Methodologies for modelling of packaged MEMS, in conjunction with EDA Vendors (M36)

 **Budget - ( Draft prior to kickoff meeting)**

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Project	2006 (M25-36)	2007 (M37-42)	10 months (M25-42)
Common sub-project	40	-	40
HERMETICITY	146	-	146
RELMETH	96	11	107
VIBSHOCK	135	20	155
ACCELEROMETER	20	70	90
Total	437	101	538

- €437k has been allocated to all 4 projects for 2006
- €40k has been allocated to the co-ordination group for 2006
- Following kick-off meeting on 28/03/2006, may be small redistributions of funds internally depending on distribution of activities

 **Impact and Self - Sustainability**

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- Need to establish a European Infrastructure for high temperature and harsh environments, this will be established through VIBSHOCK, result Virtual Lab of well recognised European Experts
- Collaboration with SoftMEMS, develop best practice guidelines, training, modelling methodologies
- Services for Accelerated Testing and Reliability Analysis, RELMETH
- 2007 demonstrator to be delivered from ACCELEROMETER
- Maximise return of investment from activities funded in first 2 years of NoE
- Industrial partners using these activities as "proof of concept" towards industrial funding of longer term activities



## Summary and Current Status

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- These projects bring together 17 NoE and 5 industrial partners
- A very high level of collaboration and joint research activities demonstrated during the first 2 years of PATENT-DfMM
- The group well poised to exploit existing results and move towards self-sustainable activities
- Test structures from ST are delivered - project will commence immediately
- Kick-off meeting of co-ordination group 28/03/2006 at IMEC
- This group will oversee linked activities and drive IPR towards establishment of virtual labs, consultancy services and business models