DfMM NoE PATENT

Information Society Technologies

European Commission

European research programmes in MEMS & MOEMS packaging/ Package Engineering

Session organised by Alan Brown, QinetiQ UK

(WP4 - Package Engineering workpackage leader)

Jul-05

Agenda

- 10:50 - Introduction to PATENT-DfMM Package Engineering activities
- 11:00 - Guest presentation
  - Rapid prototyping and packaging of microsensors for niche products - Peter Friis, DELTA
- 11:30 - Presentations on PATENT-DfMM research activities
  - Investigation of Laser Based Processes for MEMS Assembly and Packaging – Changhai Wang - Heriot Watt University
  - MOEMS Packaging for Harsh environments – Jerome Loicq, CSL
  - To develop a methodology and initial tool-set for the assessment of the impact of packaging on MEMS devices – Alan Brown, QinetiQ
- 12:30 - Lunch

PATENT (Packaging, Test and Reliability Engineering in Micro & Nanosystem Technologies)

- Design for micro and nano manufacture

WP4 - Package engineering

Alan Brown, QinetiQ
(Workpackage leader)

Jul-05

Package Engineering

- Packaging is one of the most costly and least developed aspects of microsystems technology
  - packaging typically accounts for ~70% of the cost of a microsystems device
  - packaging often has a detrimental effect on the overall performance of the sensor system
  - packaging is one of the main causes of failure / poor reliability in microsystems
- Much of the packaging technology developed to date has relied upon minor adaptation of existing packaging technologies originally developed for purely electronic integrated circuits
  - Here the main function is to protect the die circuitry and interconnections from mechanical stress and chemical attack

- These techniques are useful for some Microsystems devices such as accelerometers, which require relatively simple packaging techniques
  - However, often this is not the case
- Microsystems by their nature require direct interaction with the surrounding environment
- Certain devices, such as pressure sensors, cannot be physically isolated from the surrounding (often harsh) environment as selective access needs to be provided to the sensing / actuating parts of the microsystems device

- The makes the packaging task very complex
  - The package has to simultaneously protect the device, whilst providing access to the environment the device is supposed to interact with
- Key issues for microsystems packaging are
  - transducer encapsulation (protection)
  - connection
    - interfacing - providing access to the environment with which the sensor/ actuator structures interact
    - interconnection - to transfer signals from the device to the outside world
  - assembly

- The broad range of requirements could lead to a wide variety of very application specific packaging solutions.
  - It has been said that " there are as many MEMS packaging methods as there are MEMS devices"
- This is not sustainable position
- The need for a large range of package types would clearly limit the exploitation of microsystems devices
  - Especially as demanding testing and qualification procedures are often required

- Packaging solutions are required that can be easily re-configured or re-used for different applications
- Some form of standardisation / re-use of packaging techniques is essential
- New packaging techniques must offer a clear cost/ functionality benefit
- For a broad range of markets and applications
  - high yield ,
  - high reliability,
  - low cost,
  - manufacturable,
- packaging is a key requirement for high volume exploitation of MEMS

Manufacturability, assembly and cost issues

- The interface to the microsystems device supply chain (for example dicing/ release issues for silicon based microsystems)
- Maturity of the technology/ General quality acceptance in the industry
  - Proven mature technology
  - Well known technology for packaging electronic components and some sensor systems (proven assembly process)
  - The technology should be developed to a level where international accepted standards are available
- Equipment should exists for volume production
- The packaging supply chain infrastructure should be established (i.e. package parts available in tape and reel for mass production)

Packaging has a major impact on

cost,

performance

reliability

of the overall micro- and nanosystem device

- It is vital that **the engineering cycle, from design to manufacture, includes packaging, interfacing and assembly issues at all critical stages**.

Package Engineering – WP4

Workpackage Objectives

- To be the respected independent source of Package Engineering expertise in Europe. This will include
  - package reliability and failure analysis,
  - test structures for packaging and packaging design
  - modelling and simulation,

  in association with the other PATENT workpackages

- To make European micro- and nanosystem package engineering activities world leading

WP4 aims

- Pull together European experts in field of micro- and nano-package engineering (the interaction of interfacing/ interconnection, package and assembly)
  - Establish a virtual institute
- Integrate this “Institute” within the PATENT network
- Improve partner research through access to off-site equipment, training and prototyping facilities
- Initiate programme of Joint Research to make European activities world leading
- Initiate small promotional / marketing activity to begin to promote the activities of the Package Engineering work package

WP4 partners

- QinetiQ (work package leader)
- University of Lancaster (deputy)
- IMEC
- Tyndall Institute (formerly NMRC)
- Kathollieke Universiteit (KU) Leuven
- Budapest University of Technology and Economics (BUTE)
- Heriot Watt University
- Universite de Liege (Centre Spatial de Leige (CSL))
- Fraunhofer IZM, Berlin
- Fraunhofer IMS, Duisburg

Total budget for 12 months = 252k Euro

WP4 activities

- For the first year activities to pull together partners were based around
  - the collection/ sharing of information on the state of the art in microsystems package engineering
    - Inertial,
    - Environmental,
    - RF MEMS
    - MOEMS
    - BioMEMS
    - Microfluidics
  - Joint research
  - Improved partner research through partner visits, access to off-site equipment/ capabilities

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WP4 activities in year 1

- Key generic challenges identified for possible joint research/ technical interest working groups
  - Understanding and prediction of the effect of packaging on the performance and reliability of MEMS
    - Test structures for package monitoring both during the lifetime of the component and the design phase
    - Improved/ accurate Modelling and Simulation of the device package interaction
    - Low temperature packaging processes
  - Low cost packaging
  - Packaging for Harsh Environments
  - Understanding of issues relating to packaging as device dimensions approach the nanoscale
- Clearly a number of these are interlinked

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WP4 activities in year 1

- Three joint research projects were funded, addressing some of these challenges, including
  - Investigation of Laser Based Processes for MEMS Assembly and Packaging
  - MOEMS Packaging in Harsh Environment
  - WP4 led cross work package activity involving all four technical work packages – "To develop a Methodology and initial tool-set for the assessment of the effect of packaging on the performance and reliability MEMS devices"
- A single application was received for a grant for improved partner research through partner visits
  - Bi-lateral study visit between ULAN and IZM - FEA and modeling of IMS packaging structures using ANSYS

WP4 objectives for M13 –M18

- **Continue to pull together European experts in field of micro- and nano- package engineering**
  - Establish a virtual institute
  - Integrate new partners
- **Further integrate this "Institute" within the PATENT network**
  - Good links to WP2 & 3, improve links to WP1
- **Continue programme of Joint Research to make European activities world leading**
  - New projects/ new phases of existing projects
- **Promote improved partner research through access to off-site equipment, training and prototyping facilities**
- **Initiate Sales and Marketing activities to promote the activities of the Package Engineering work package**
  - Initiate semi-commercial projects/ commercial activities
- **Establish links to external working groups other NoEs and IPs**
  - Re-launch NEXUS USC MEMS Packaging, AMICOM etc.

Vision for next 18months

- The Package Engineering work package will evolve to offer a brokerage service and act as a one stop shop for access to all aspects of packaging DfMM from small research projects to volume packaging requirements. This will include
  - package reliability and failure analysis,
  - test structures for packaging and packaging design,
  - modelling and simulation,

  in association with the other technical work packages
- As the work packages begins to promote its commercial services
  - a number of semi-commercial projects will be initiated demonstrate the concept/ capabilities of the virtual laboratory

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