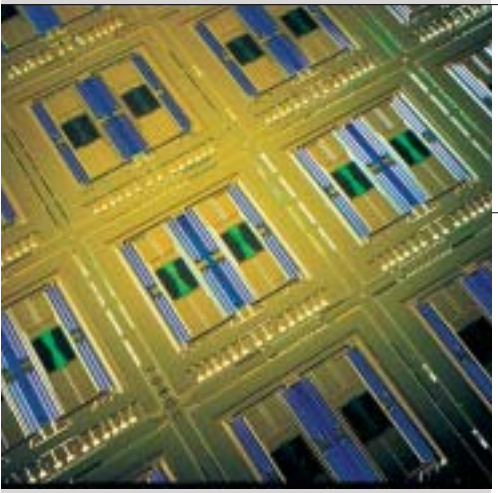
PROJECT RESULT

Packaging



T503: Novel packaging technologies for highly integrated micromodules for next generation telecom and automotive products (HI-MICRO)

Good things come in smaller packages

Progressive deregulation of the electromagnetic spectrum above 2 GHz has been a boon to suppliers of civilian microwave and millimetre-wave systems. However, though growing, the market is still small with few customers paying high prices. If the front-end circuits could be more highly integrated and contained in advanced electronics packages such as the microlead frame, it could become a mass market. This is exactly what the MEDEA+ T503 HI-MICRO project has achieved. It has put European suppliers in a position to compete with Japanese and US companies that pioneered developments in this area.

The market for microwave and millimetre-wave applications is substantial. Wi-Fi hotspots, where mobile subscribers can access wireless local area networks (WLANs), for example, owe their existence to point-to-multipoint millimetre-wave radio transceivers. The downloading of large volumes of multimedia information by mobile Internet users is undoubtedly accelerating the demand for these products. In the automotive sector, anti-collision and cruise-control aids based on microwave radar can be selected as options on top-of-the-range cars from some manufacturers.

Demand for these applications is forecast to grow into a mass market in the medium term. However, neither of these market segments will realize their potential unless the products can be mass-produced at low cost. The MEDEA+ T503 HI-MICRO project has made a big step in this direction by developing know-how and tools to facilitate design and production of highly-integrated millimetre-wave and microwave circuits in compact electronics packages such as flipchips, chip-scale packages (CSPs) and ball grid arrays (BGAs).

Already found in high-volume consumer electronics, these advanced packaging technologies have so far lain out of reach of millimetre-wave and microwave circuit designers due to both cost and technical barriers.

Harsh environments

An impediment in the automotive sector is the harsh environment that devices mounted on vehicles have to endure. Even when not located under the bonnet, the packages and their adhesion to circuits boards still must be able to tolerate physical stresses, humidity and temperature variations not normally experienced by consumer electronics products. A device packaged in an ordinary BGA or microlead frame (MLF) – a CSP variant already accepted by the automotive industry – would fail rapidly. Flipchips have been used in automotive products from the US and Japan but only in small numbers.

To tackle this problem, the HI-MICRO consortium compiled an exhaustive list of degradation and failure mechanisms, identified the most important and studied their actual occurrence by subjecting sample packages to regimes of appropriate environmental stresses. From the results of these tests, they built and validated computer models of the mechanisms. The lessons learned will help all of the consortium members to shorten development times and ensure the reliability of new products. The tests they developed are already in use for qualification of chips.

This work required accurate identification of the causes of failures observed in

experimental test chips. New analytical techniques had to be developed for this, including ways of removing encapsulation materials from chips, which otherwise mask cracks and other evidence of failure. Good results were obtained with a method devised by automotive systems house Robert Bosch and major chipmaker STMicroelectronics; this involved removal of the material without unduly damaging fine metal features such as wires and copper lines.

New circuit designs

Though not prone to the same environmental extremes, millimetre-wave and microwave circuits for telecommunications in advanced packages for high-volume production are so far unknown. To complicate matters further, the performance of high-frequency circuits in novel packages is strongly affected by feature forms – such as solder bumps and laminates – that are absent from standard packages. So new design rules had to be established.

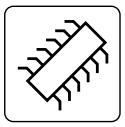
The consortium's approach to this challenge was three-pronged. It refined theoretical models of flipchips and assemblies so that their behaviour in a range of different packages could be simulated mathematically. With these models for aids, HI-MICRO designed monolithic microwave ICs (MMICs) and test chips with which to assess the different technology options. And it developed substrates and interconnect techniques suitable for carrying and interconnecting the chips.

Creation of two demonstrators gave a tangible focus to these interlinked efforts – a 60-GHz WLAN transceiver based on gallium-arsenide (GaAs) components and a 23/24-GHz demonstrator including silicon-germanium (SiGe) flipchips mounted on low-temperature co-fired ceramic substrates. The three prongs were executed in parallel, allowing continual feedback between all three and gradual refinement of the simulation models, substrates, test chips, assemblies and demonstrators.

Merged packaging projects

The partners have taken away different benefits from this MEDEA+ project. Robert Bosch has enhanced its competitive position alongside companies in Japan and the US pioneering advanced electronics packages in road vehicles. For telecommunications systems house Ericsson Microwave Systems, the progress made towards mass producing microwave and millimetre-wave circuits has boosted its continuous cost-reduction programme and reinforced its market leadership. And chip and module suppliers STMicroelectronics and Acreo have extended the range of devices and services they can offer to customers; this will be invaluable when automotive radar sets and microwave radios may become commodity products.

HI-MICRO was a marriage brokered by MEDEA+ of two independent project proposals with similar aims relating to electronics packaging. Despite these beginnings and the withdrawal of one partner due to lack of funds, it flourished. Only two of the partners had collaborated before. So successful has it been, that the consortium members have got together with new partners and drawn up a proposal for a more ambitious new project they hope to launch soon.



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Partners

Acreo
Chalmers University of Technology
EPCOS
Ericsson Microwave Systems
Robert Bosch
STMicroelectronics

Project leader

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Key project dates

Start: April 2001
End: June 2004

Countries involved

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Germany
Italy
Sweden

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