Electronics, Photonics & Sensors at TWI

Electronics, Photonics & Sensors are fundamental to the operation of most of today’s products and infrastructure and consequently can have a significant influence on a company’s well being.

TWI has been active in this area for over 40 years. During this period we have assisted companies to produce cost effective, reliable products and solutions through the provision of simple advice, materials and process selection, prototyping and production line troubleshooting.

TWI is able to meet the challenges of this fast moving sector by maintaining an understanding of the technical and financial pressures facing manufacturers, and thus provide a continuous developing range of support services. TWI strengths in this area are as follows:

- Absolute confidentiality
- Rapid response
- Multidisciplinary approach
- Knowledge based on practical experience
- >40 years experience
- Prototyping capabilities
- A broad global knowledge of technologies and trends

TWI Background

TWI Ltd is a worldwide recognised centre for materials, joining and assembly technology. It has been based at Cambridge for 70 years and supports in excess of 4500 member company locations in 90 countries. 850 staff are employed in its research laboratories to supply industry with technical and support services. Services range from product design assistance through development of materials and processes to the assessment of manufacturing systems, production line troubleshooting and staff training. Electronics, Photonics and Sensors experience at TWI includes the following:

Electronic Packaging

TWI has been actively involved in electronic packaging for over 40 years. Work has covered all aspects of chip attachment (adhesives, soldering, glass, mechanical etc), interconnection (flip chip, TAB, wire bonding, adhesives etc), encapsulation (glob top, potting, plastic moulding), hermetic sealing (soldering, brazing, welding, glass fusion) and substrate/board assembly.

Additional key elements of TWI’s work include: product design/modelling, quality assessment/control, testing (eg mechanical, thermal and environmental), manufacturability and troubleshooting.

Typical projects include:

- Development of Al and Cu wire ball bonding
- EMI shielding for discrete devices
- Assessment of flip chip bonding techniques
- Low stress hermetic sealing technology
- Development of a large area die rework station
- Fine pitch soldering technology
- Packaging technologies for the display/sensor industry
- Miniaturised electronics/sensors for medical implants
- Performance of resin encapsulants/potting materials
- Integrated passives
- High thermal conductivity die attach techniques
- High thermal conductivity packaging

Board Level Assembly

TWI has a broad background in PCB technology, covering, rigid and flexible board materials, Surface Mount (SMT), Through-Hole (TH) and Chip-on-Board (COB) technology.

During the last 10 years emphasis has been given to assist companies making the transition to lead-free soldering.

Below is a selection of the many PCB projects TWI has undertaken in recent years:

- Pb-free soldering for consumer & automotive sectors
- Selective soldering
- No clean flux selection
- Conductive adhesives for SMT & space environments
- PCB finish evaluation
- High temperature board selection
- Solder joint failure analysis
- Development of an in-line PCB inspection system
- Solder replacement
- Development of COB technology
- Low temperature soldering of sensitive devices
- Integrated passives
- Lasers drilling and cutting PCB’s
High Temperature & Harsh Environment Packaging

In the last 5-10 years there has been a significant increase in activities in electronics and sensor packaging for high temperature and harsh environments (e.g., chemically active, mechanically stressed). To address the technology needs in this area, TWI uses cross-disciplinary teams from its Microtechnology, Ceramics, Glass, Films/Coatings Technology, Polymer Resin, FEA Modelling, Non-destructive/Environmental testing and Manufacturing Processes Groups.

This approach enables all the packaging elements to be considered at an early stage, using equipment and solutions from both inside and outside the traditional electronics/sensors technology industries.

Typical projects/activities include:

- High operating temperatures electronics (e.g., 150°C - 400°C).
- High temperature sensors (e.g., 300°C - 800°C).
- Evaluation of highly accelerated stress testing for high temperature components.
- Optical fibre packaging for harsh environments (high pressure/temperature/chemically active).
- Replacement of soldered interconnects with welded joints.
- Development of a low stress, large area die/substrate attach design through FEA/thermal modelling.
- Verification of thermal modelling software through IR measurements of power devices.
- Assessment of high temperature adhesives.
- Joining of SiC with modified and active braze alloys.
- Braze alloys for ceramic/metal joining with reduced thermal stress.
- Assessment of packaging materials for hot water environments.

Optoelectronics & Displays packaging has been a significant activity at TWI for approximately 25 years. Work in this area has expanded to cover:

- OLED packaging
- ITO replacement and Printable ITO
- Precision optical fibre attachment and packaging
- Low heat input/hermetic sealing
- Flat panel display ruggedisation
- Development of alignment jigs
- Troubleshooting opto-packaging production problems
- Impact of assembly materials/processes on optical fibre alignment/stability
- Laser/diode alignment/attachment systems
- Development of glass attachment systems

To address work in these areas, TWI brings together its skills and experience in optoelectronics packaging, materials (metals, polymers, ceramics and glass), adhesive/encapsulant systems, surface conditioning, finite element modelling, inspection, NDT, QA/QC and manufacturing systems.

Sensors

TWI has significant experience in the development and assembly of sensors for the automotive, aerospace, petrochemical, medical and consumer products industries. This has ranged from developing assembly technologies for relatively low cost sensors to sophisticated packaging for applications involving high temperatures and harsh environments.

Typical sensor product/development activities include:

- Development of high temperature ultrasonic sensors
- Development of ultrasound medical catheters
- Environmental sensor for planetary research
- Optical fibre sensor for down-hole monitoring
- Pressure sensor for automotive fuel injection unit
- Fluid level sensor for automotive application
- Temperature sensor/transducer for consumer products
- Development of a fatigue gauge for metal structures
- Ultrasonic inspection systems for aircraft wings
- Corrosion and damage monitors for pipelines
- Fluid/gas flow sensors
- Fluid, Gas & Vacuum Packaging of MEMS devices
- Low stress packaging for micromachined sensors
- Embedding sensors in composite structures
- Anodic bonding silicon sensors
Medical Devices

TWI is working with medical devices companies to improve their efficiency of manufacture and product development through services to enhance design, materials and process selection and reliability.

Many of these medical devices require advanced electronic and sensor technology to monitor and control performance and record and display data. TWI utilises its knowledge of electronics and sensor packaging, telemetry and medical materials to provide advice and solutions.

Typical work areas include:

- Smart long term implants
- Catheter and pacemaker technology.
- Bioactive and biodegradable materials.
- Drug delivery systems.
- Surgical tools and diagnostic equipment.
- Adhesives for wound dressings.
- Orthopaedics – bone cements, wear resistant coatings.

Microjoining & Assembly

The joining and assembly of small products and components has been a core skill at TWI for over 40 years. It uses this experience to help companies to select the most cost effective solutions to meet their requirements.

Typical microjoining project areas include:

- Motor and battery connections
- Replacement of solder for automotive leadframe connections
- 10µm Pt wire welding for a space environmental sensor
- Attaching Ag electrical contacts on tri-metal based thermal cut-out systems
- Developing seam welding technologies for aluminium screening material on cables
- Brazing and welding carbide drill bits
- Laser and resistance welding of thin metal foil
- Development of polymer enclosure system for consumer products
- Assessment of soldering/welding/adhesion technology for the lighting industry
- Development of brazing and welding for jewellery
- Joining insulated wires.

Micromachining & Surface Engineering

TWI has conducted an extensive review of micromachining technology and is currently involved in the development of high energy beam (e.g. laser and electron beam) machining and surfacing techniques.

Typical projects include:

- Micromachining of ceramics for sensor applications
- Drilling micro holes in glass for the pharmaceutical industry
- Drilling via holes in green state ceramics and epoxy laminate
- Developing machining techniques for thin metal foils for the medical, consumer and chemical industries.
- Developing ceramic dielectric coating technology for the electronics industry
- Developing Sol Gel wear/water resistant coating technology
- Developing surface texturing techniques for improved thermal management
- Improving surface adhesion characteristics of metals and polymers.
Environmental Legislation

Global environmental legislation has resulted in a total rethink of product design and manufacturing processes in a range of industrial sectors, including electronics, consumer products and automotive.

TWI with its extensive knowledge of materials, assembly technology and environmental conditions/requirements has found itself ideally placed to assist companies in assessing the impact of environmental legislation on current product lines and the design of the next generation of products.

Typical TWI’s activities in this area include:
- Environmental Audits (products/processes)
- Biodegradable circuit boards
- Lead free solder for circuit boards
- Ionic liquids for disassembly
- Recycling of electronics/biomass into energy
- Reuse and remanufacture.
- Product life-cycle assessments
- Design for disassembly

Prototyping

TWI, using its extensive laboratory complex and close links with equipment and material suppliers can assist companies through the prototyping of technology and product demonstrators.

Typical products:
- Assembly of a space sensor
- Design and assembly of an ultrasound catheter
- Design and build of a model gut system

Validation, Reliability and Test

“Reliability is an assurance of operation that makes best use of resources, allows a product to be used as intended and develops customer loyalty”

TWI has extensive experience in helping companies to design products that work for the desired period of time. This has involved assessing the reliability of joints, structures and products in a wide range of applications.

Services and facilities include:
- Design for reliability and design for life.
- Analytical (finite element) modelling.
- Failure analysis and troubleshooting
- Virtual qualification.
- Mechanical and environmental testing.
- Stress analysis.
- Non Destructive Testing & Inspection.
- Precision reliability.

Manufacturing Implementation, Quality Assessment & Control

TWI has a long history of assisting industrial companies to improve product and process yields and establishing techniques for monitoring and control.

Services and facilities include:
- Product/production line troubleshooting
- Design for manufacture/service life
- Materials Analysis
- Product Inspection and Testing
- Manufacturing systems analysis/modelling
- Global Supply Chain Management
- Failure Analysis

Further Information/Assistance

The above outlines just some of the many services and facilities available to industrial companies at TWI.

For further information or assistance please contact:
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