Microtechnology for the HighTec Medical Industry

-micro packaging as an enabler for next generation devices-

Erik Jung, Fraunhofer IZM

Erik.jung@izm.fraunhofer.de

Forschungsschwerpunkt Technologien der Mikroperipherik

Fraunhofer IZM

Technologies from MST which lend themselves for the medical arena

Component enhancement

- Zero Level Packaging, Lens Attachment, Hermetization, …

Substrate manufacturing

- Flex circuit manufacturing
- Non-standard PCB material use and fabrication
- Functionalization
- Duromer MID

Component assembly

- Die and Wire Bonding
- Thin Chip Assembly
- Flip Chip/CSP Assembly
- SMD Assembly
- Welding

Forschungsschwerpunkt Technologien der Mikroperipherik

Fraunhofer IZM

Technologies from MST which lend themselves for the medical arena

Encapsulation

- Mechanical Protective Layer
- Silicone biocompatibility layer

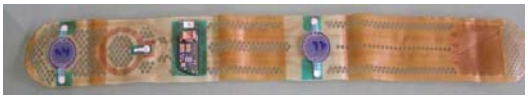
Barrier Layer Deposition

- Parylene conformal coating
- DLC deposition
- ALD of Al2O3

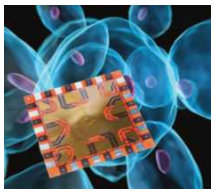
Functional Layer Deposition

- PEG, DEL, HAD

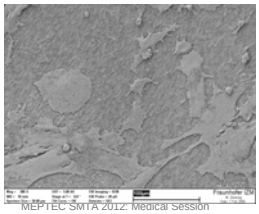
Substrate Technology



Flex Circuitry
-15µm thick
-5µm lines/spaces
-180° bending
-Typically PI or TPU

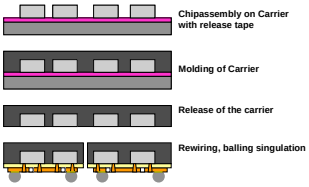


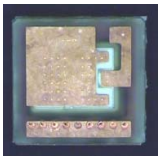
Semi-Flex Circuitry
-150µm thick
-25µm lines/spaces
-6 layers
-Au, Pt, Al metal layers



Functional surface substrates
-Membrane type of base substrate
-Plating and structuring of Au, Ni and Sn
-Better than 1:10 aspect ratio of nanorods
-Deep sub-µm structures

Molded Duromer System In Package – Substrate is already the System!



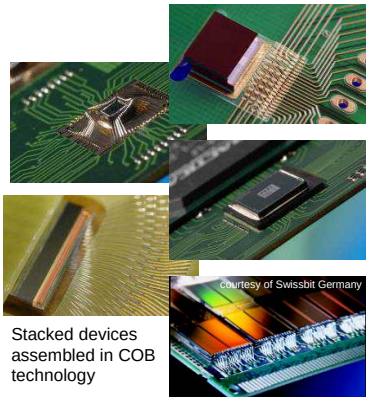


Short distance interconnects by direct wiring technology

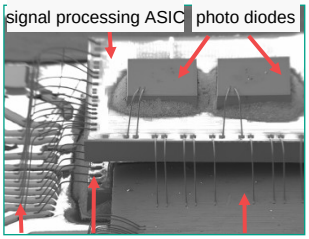
Homogenous height in the entire system, flat top surface

Through-Mold Vias instead of Through-Silicon Vias

Chip-on-Board Stacking Technology

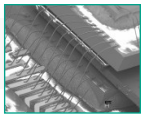


Stacked devices assembled in COB technology



PCB controller EMC shielding

Wire bonding at different device levels (1mil AlSi1)



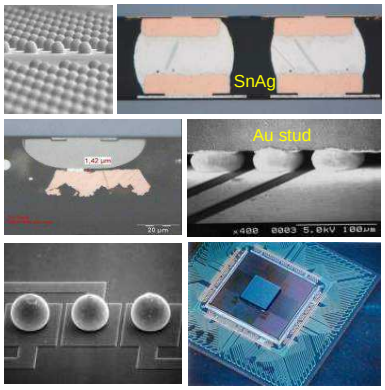
S. Schmitz

Flip Chip Technologies

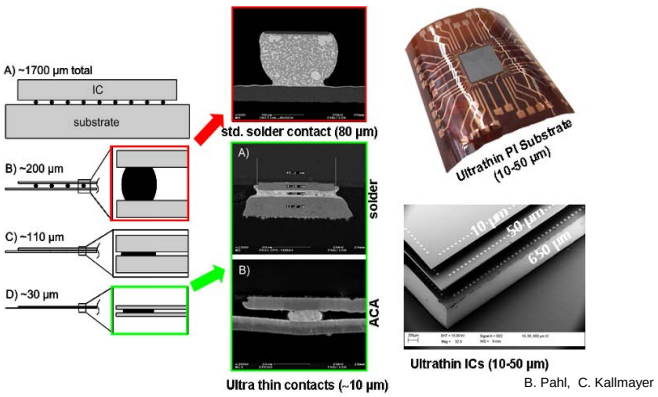
Thermode Bonding
- Thermocompression
- Thermosonic

Reflow soldering

Adhesive Joining
- ICA - Isotropic Conductive Adhesive
- NCA - Non Conductive Adhesive
- ACA - Anisotropic Conductive Adhesive

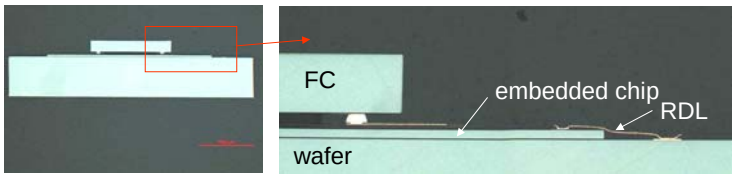


Ultra Thin Flip Chip Interconnects

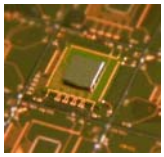


B. Pahl, C. Kallmayer

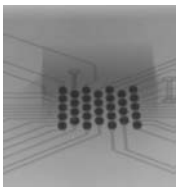
Thin Chip integration: Reliable System Level Integration of Stacked Chips on MEMS



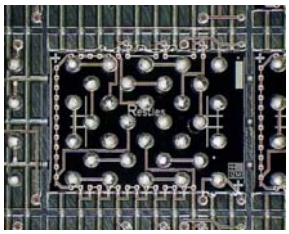
cross section of a three chip stack using chip embedding: thin chip embedded on wafer, formation of a RDL, FC-Bonding



Top view



Bumped TCI on wafer level



Chip scale package integration of different microsystem technologies by thin die stacking, polymer embedding and redistribution/bumping

Forschungsschwerpunkt Technologien der Mikroperipherik

Fraunhofer IZM

Examples on medical devices benefitting from MST use

Technology Examples

Forschungsschwerpunkt Technologien der Mikroperipherik

Fraunhofer IZM

Active Implants

Active implants optimize diagnostic, therapy and thereby the overall quality of life of patients

Micro system technology allows to realize the active functionality in an acceptable implantable form factor

Example: Pace maker, cochlea-implant, cortical pressure sensor, hearing aids, glucose measurement systems, video endoscopse, brain computer interfaces, retinal implants, intraocular pressure sensors

Pace Maker (Cooperation with Biotronik) | Intra-ocular pressure sensor (Cooperation with Mesotec) | Retina-Implantat (Cooperation with IIP) | Wireless Brain Computer Interface (Cooperation with Uni Utah) | Telemetric intracranial pressure sensor (EU Projekt HEALTHY AIMS)

Ageing in Autonomy and Dignity

Sensory and AAL assisted life allows high autonomy pertaining high safety to the elderly patient

Ubiquitous availability of services due to micro system technology

Example: Safety bracelet, fall detection, monitoring of dementia, stroke rehabilitation assistance

Wrist worn distress signal (Kooperation Uni BW)

Localization Module for patients with dementia (Cooperation with Fort Supply Technology, USA)

Sensory assisted orthesis (Fraunhofer Vision: Robot in Touch)

MEPTEC SMTA 2012: Medical Session Erik Jung, SIIT

© Fraunhofer IZM

Wrist band to assist in elderly care

Part 1: LowCost-wrist band

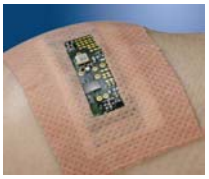
1) Electroluminiscence-Display realized in roll-to-roll technology

Part 2: Modular concept to integrated additional functions

Multisensor attacheable

Wireless transmitter

Energy autonomy/scavenging



2) Foil Sensors integrated using roll-to-roll technology

Forschungsschwerpunkt Technologien der Mikroperipherik

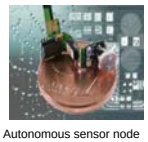
Fraunhofer IZM

Patient Care

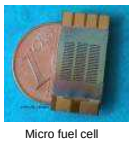
Cost reduction and optimization of patient care by autonomous monitoring (tele-health)

MST as enabler for autonomously (re) acting sensor/actuation scenarios

Examples: Sensor nodes, autonomous energy supply, intelligent vital data sensors



Autonomous sensor node



Micro fuel cell for extended life time of sensor nodes

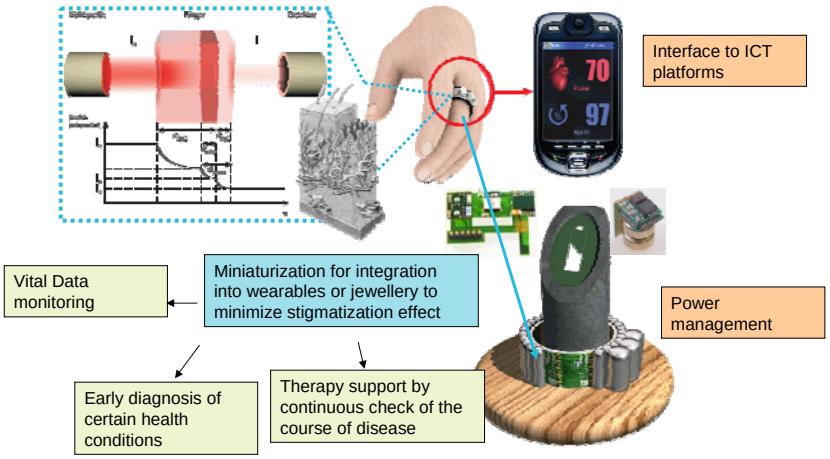
Bluetooth enabled vtal data monitor (pO2, T, Zskin, pulse)

Textile integrated EMG electrodes
Electronic module with wireless interface

Forschungsschwerpunkt Technologien der Mikroperipherik

Fraunhofer IZM

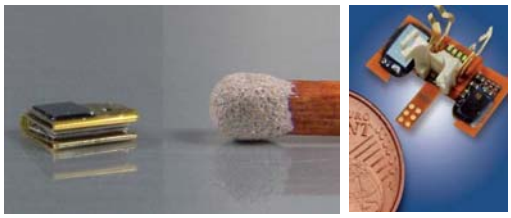
24/7 health monitoring



(K.-D. Lang, St. Guttowski, Christine Kallmayer, et al. IZM Berlin)

Augmenting deteriorating senses

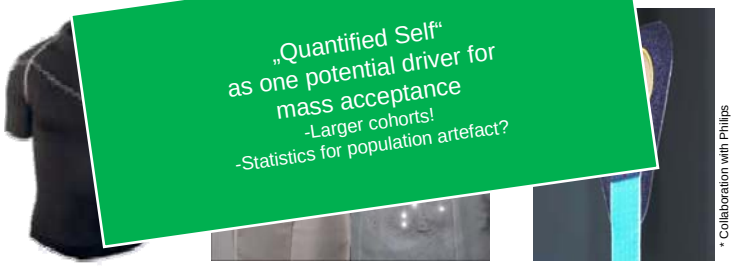
- Hearing aids which become invisible and offer higher functionality
- Flip Chip usage, small(est) SMD usage, flex substrate usage



Offering novel opportunities for patient care and disease prevention

- Textile electronics for distributed sensors by large area electronic integration
- Washability @ 60(95)°C for hygiene reasons
- Look-and-Feel for patient acceptance
- Robustness and safe performan… g

„Quantified Self“
as one potential driver for
mass acceptance
-Larger cohorts!
-Statistics for population artefact?



ECG | Respiration and Movement | EMG*

* Collaboration with Philips

Forschungsschwerpunkt Technologien der Mikroperipherik

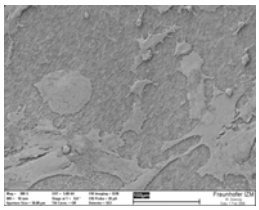
Fraunhofer IZM

Emerging: Bio-Inspired Sensors and Therapy

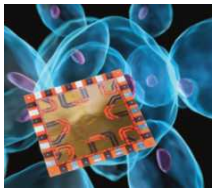
Merging biology and electronic in smallest form factor

Micro system technology is –again- enabler

Example: Drug- and pathogen detection, cancer therapy using electronically selected killer cells,



Neuronal growth on nanostructured support suitable as living sensors e.g. for neurotoxins (cooperation with U. Rostock)

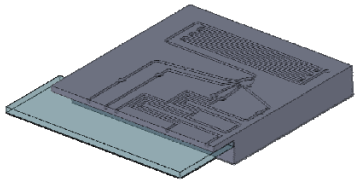


Platform to detect natural killer cells suitable for optimizing tumor treatment (collaborative activities in EU Projekt COCHISE)

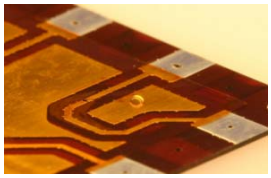
Forschungsschwerpunkt Technologien der Mikroperipherik

Fraunhofer IZM

Medical Device Challenge:
Point of Care Diagnostics and Therapy



Complex diagnostic systems
call for integrated sensors and
sample treatment with
low cost implementation strategies



Micro-Packaging is key to achieve this

-µ-fluidic/µ-electronic integration
-Sensor/actuator integration
-µ-fluidic and µ-electrical interfaces
to the outer world

Forschungsschwerpunkt
Technologien der Mikroperipherik

Fraunhofer IZM

Video

MEPTEC SMTA 2012: Medical Session Erik Jung, SIIT

© Fraunhofer IZM

Forschungsschwerpunkt
Technologien der Mikroperipherik

Fraunhofer IZM

Technology Examples: MST in medical applications

Hearing Aids

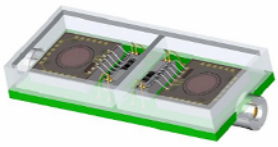
Endoscopic camera systems (chip on tip)

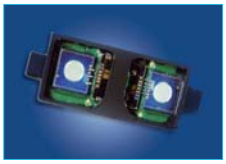
Brain Computer Interfaces

Forschungsschwerpunkt Technologien der Mikroperipherik

Fraunhofer IZM

1: Hearing Aids: Microphone Packaging and Device Assembly





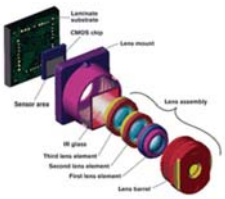
Use of a silicon MEMS microphone, stressfree die-attach, wirebonding and cavity protection

Use of flip chip technology, thin/ultrathin flex substrate, 01005 SMD components

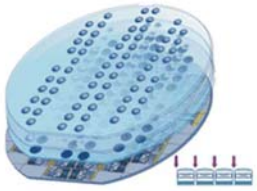
Forschungsschwerpunkt Technologien der Mikroperipherik

Fraunhofer IZM

2: Wafer-Level-Cameras for endoscopic use



Usual Micro Camera Assembly*



Aufbau von Kameramodulen in Waferlevelmaßstab *

Wafer level fabrication of the optically integrated camera system

•CMOS chip with Through Silicon Vias and CSP backside contacts
•Wafer bonded optical system with dual lens and spacer

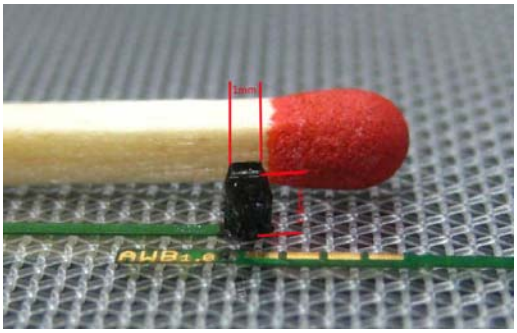
* Bildquelle: Zoberbier/Völkl „Inside Wafer-Level Cameras" www.semiconductor.net

Forschungsschwerpunkt Technologien der Mikroperipherik

Fraunhofer IZM

Cooperation with AWAIBA and SUSS resulted in world record in integrated camera system

Assembly on 1,5m long miniature flex substrate strip (roll-roll fabrication)



Forschungsschwerpunkt Technologien der Mikroperipherik

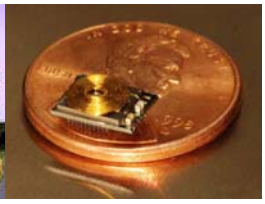
Fraunhofer IZM

3: Brain Computer Interfaces

Miniaturiziation, Biocompatibility, Wireless Data, Longevity

- •Wafer Level Redistribution and Bumping for Miniaturization
- •Flip Chip Assembly for Miniaturization
- •Hermetic lidding for longevity
- •Wireless energy and data
- •Silicon-on-Silicon integration for performance and longevity
- •Biocompatible choice of materials and encapsulation



Collaboration with University of Utah within a NIH Grant

Forschungsschwerpunkt Technologien der Mikroperipherik

Fraunhofer IZM

Synopsis

Micro technology and micro system technology offer new opportunities to use innovative techniques and convert them into novel products.

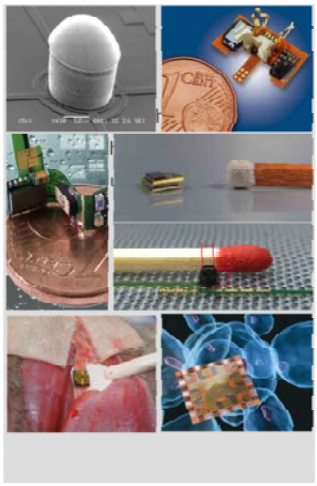
New and improved diagnostic and therapeutic concepts can be realized by leveraging these technologies

Forschungsschwerpunkt Technologien der Mikroperipherik

Fraunhofer IZM

SMTA
Surface Mount Technology Association

MEPTEC
THE NEXT GENERATION



Research and Development for Medical Micro Systems

- Engineering support for manufacturing and integration of medical micro systems
- Design for Reliability and Verification of Reliability
- Exhaustive technology portfolio to help our customers to pave the way from concept to product
- Redistribution of chips and wafers
- Hermetization by metal or glassivation
- Polymeric packaging
- Miniature system realization
- Ultrafine substrate manufacturing in rigid and flex
- Opto-electrical system design and manufacturing
- System level design and simulation
- Manufacturing process for prototype and pre-fabrication volumes

Forschungsschwerpunkt Technologien der Mikroperipherik

Fraunhofer IZM