FLEXIBLE AND STRETCHABLE CIRCUIT TECHNOLOGIES FOR SPACE APPLICATIONS

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5TH ELECTRONIC MATERIALS, PROCESSES AND PACKAGING FOR SPACE

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Cmst

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INTRODUCTION

Space products used to drive technology development

Consumer electronics or now driving advances in packaging and interconnection

- Reduction in form factor
- Increased functional density
- Enlarged user comfort

Space applications also benefit from

- Reduced volume and weight
- Increased electrical performance
- Larger design freedom
- Improved interconnect reliability

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COMPONENT EMBEDDING (PCB)

Passive Component Embedding for Space Applications (PCESA) project (ESA/TRP)

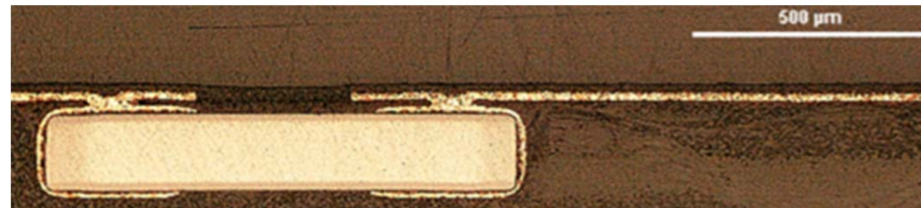
Goal

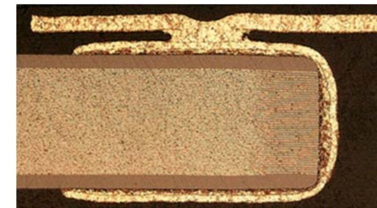
- Investigate the suitability of embedding passive components in printed circuit boards for space applications

Approach

- Overview of available technologies for component embedding
- Evaluation of reliability of passive component embedding
- Realization of a functional demonstrator
- Procedures for procurement and qualification of PCBs with embedded components for space applications

QinetiQ Space





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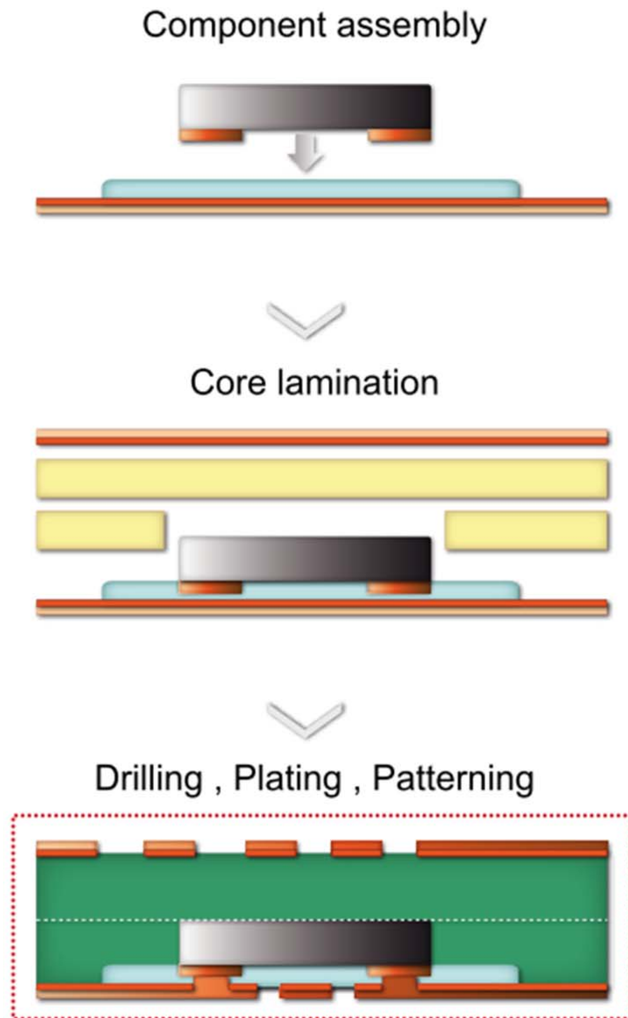
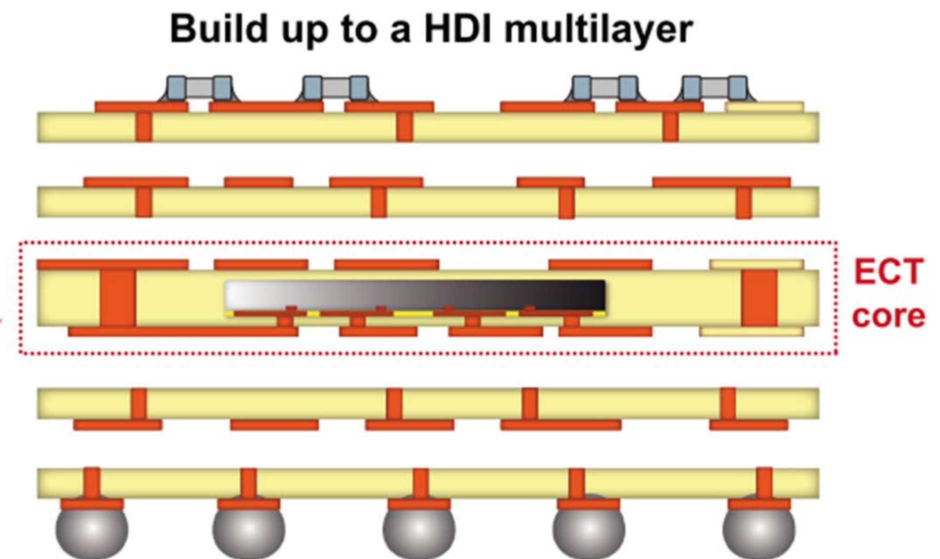
COMPONENT EMBEDDING

AT&S
www.ats.net



Embedded Component Packaging technology from AT&S

- Active and passive components
- Microvia interconnection
- System-in-Package or System-in-Board



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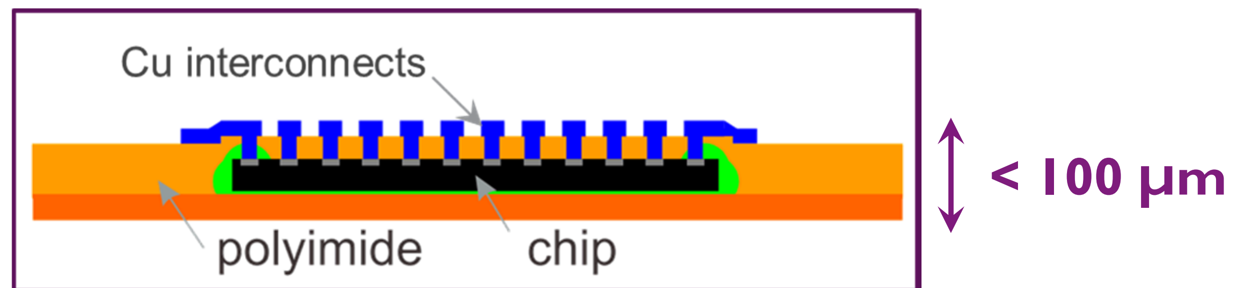
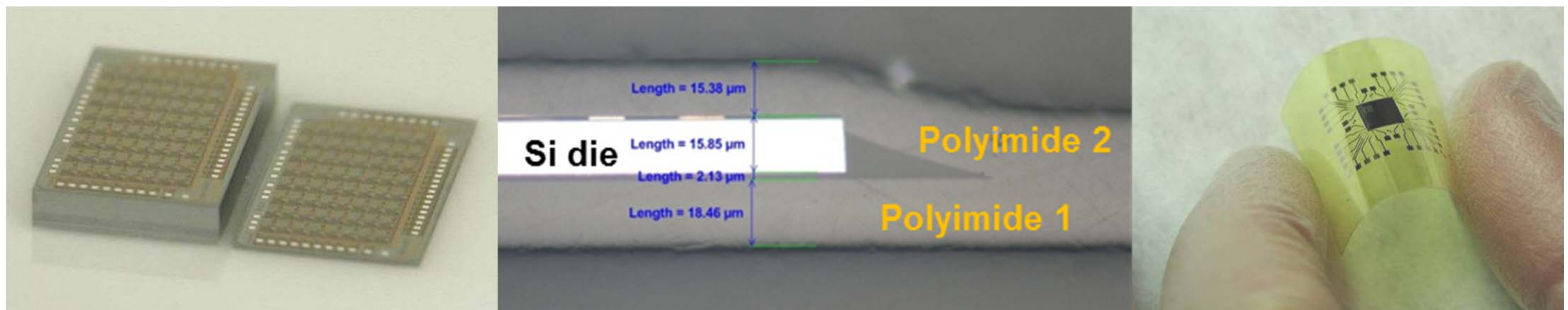
ULTRA-THIN CHIP PACKAGE

Reduce package thickness by order of magnitude

- Ultra-thin chip (20 – 30 µm thickness)
- Embedded in polyimide layers
- Fan-out interconnection scheme





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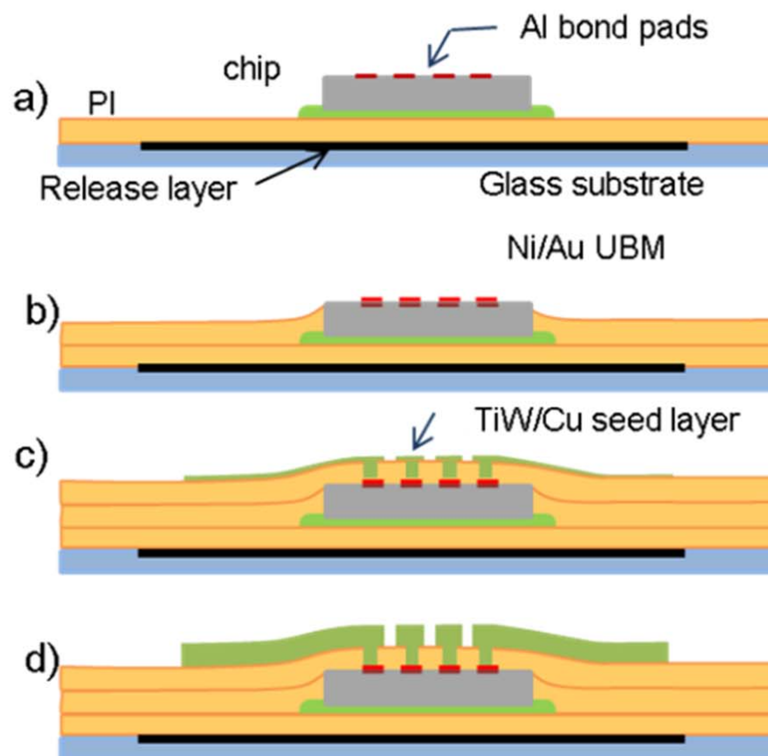
ULTRA-THIN CHIP PACKAGE

Process flow for realizing the ultra-thin chip package



- Evaporate KCL release layer
- Spin & cure bottom polyimide
- Place thinned die

- Spin, pattern & cure cavity layer
- Apply ENIG finish

- Spin, pattern & cure via layer
- Apply metallisation seed layer

- Electroplate Cu
- Pattern and etch Cu
- Release UTCP

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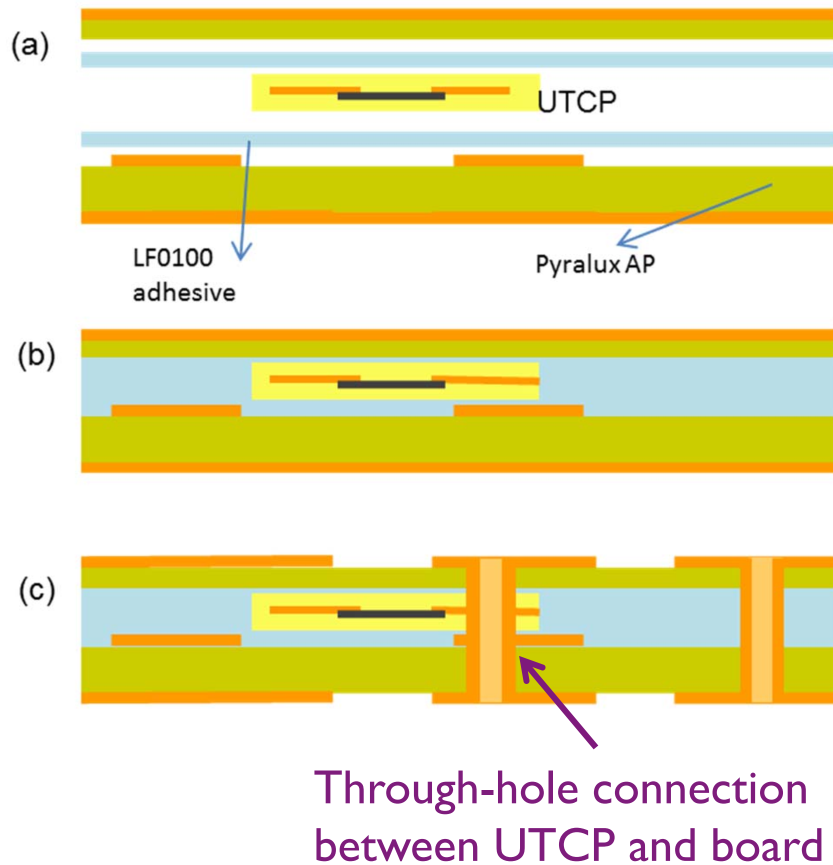
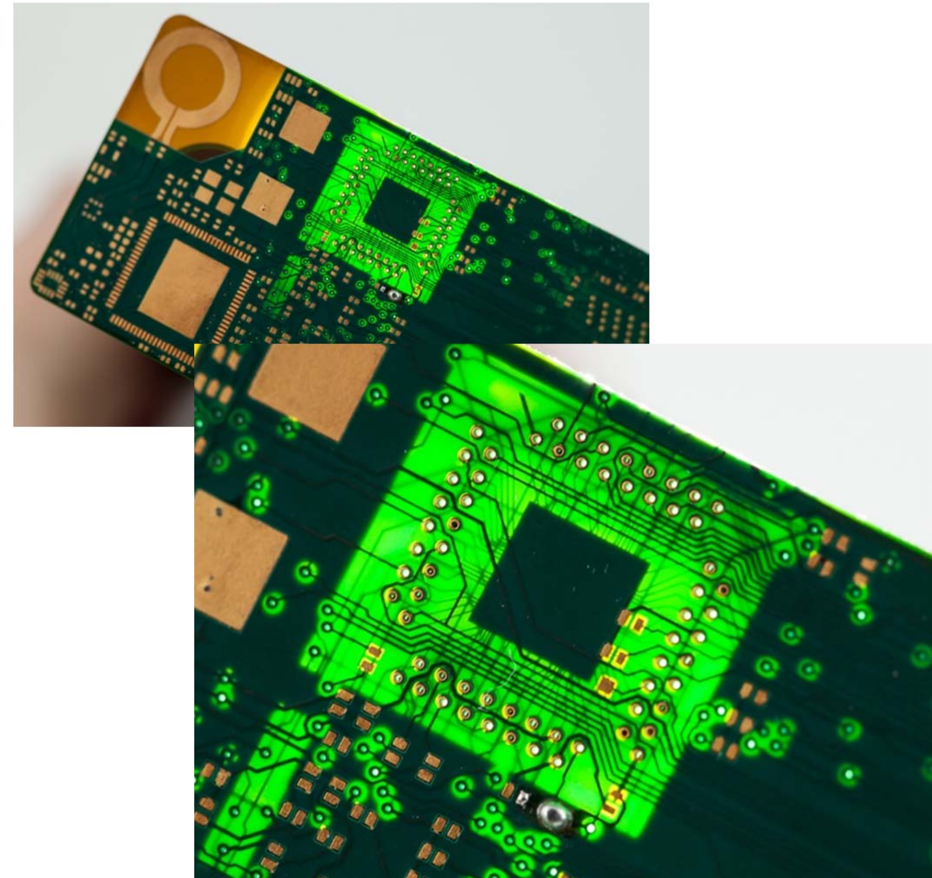
ULTRA-THIN CHIP PACKAGE

UTCPs can be surface-mounted or embedded into (flexible) printed circuit board





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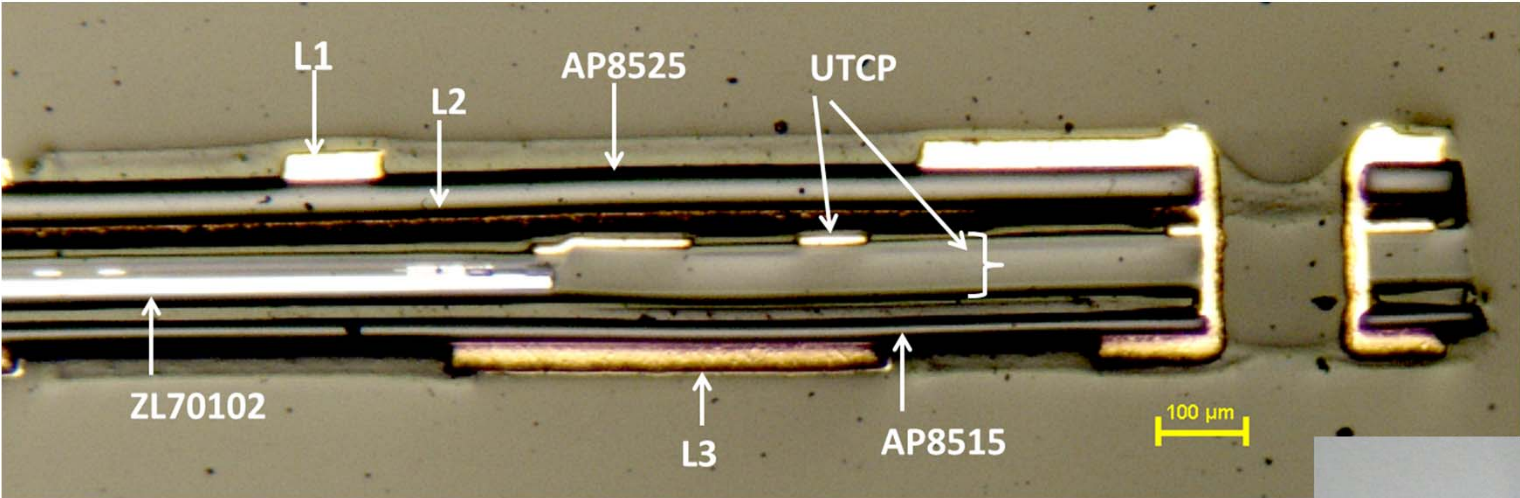
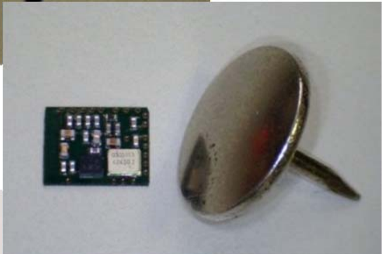
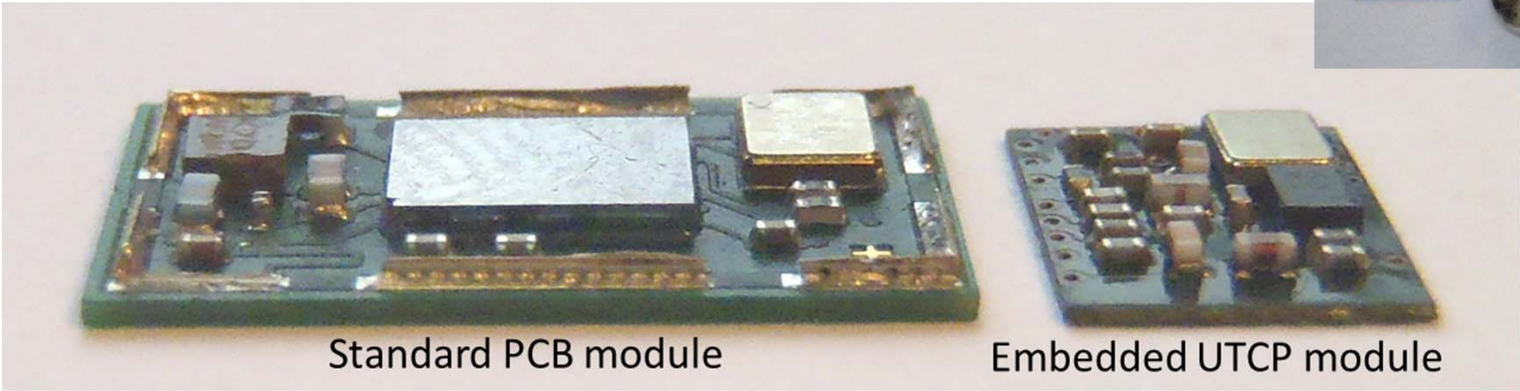
ULTRA-THIN CHIP PACKAGE



UTCP of a RF transceiver (ZL70102 from Microsemi), embedded in a three-layer flexible circuit board





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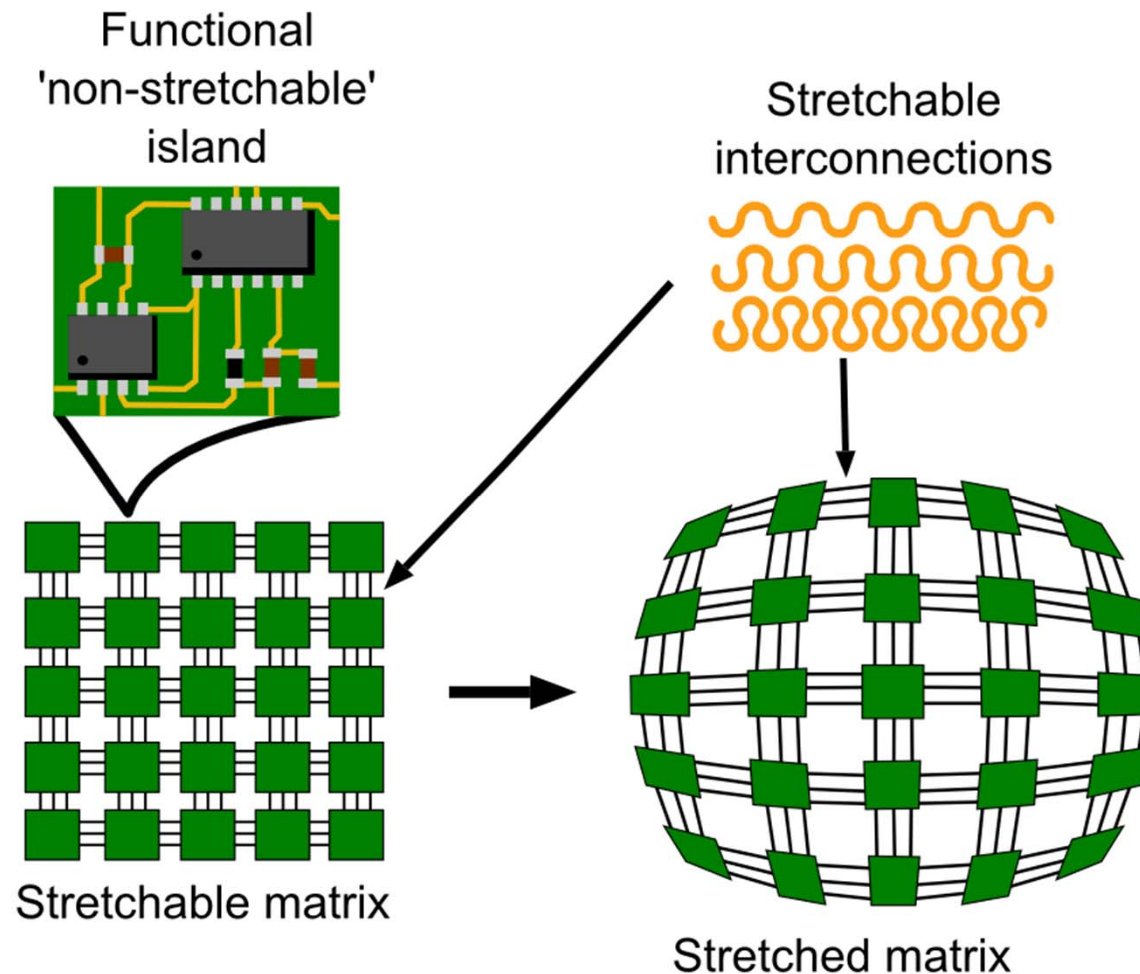
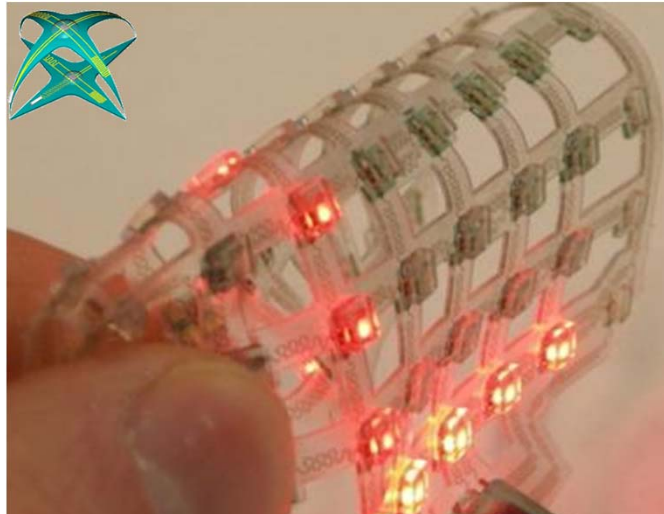
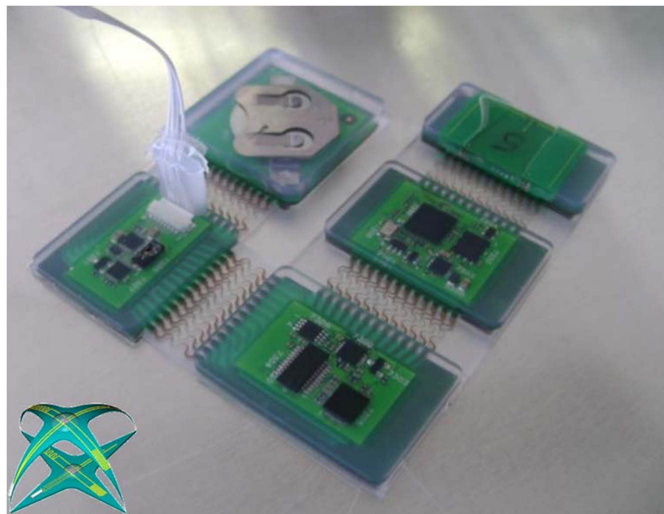
STRETCHABLE MOULDED INTERCONNECT

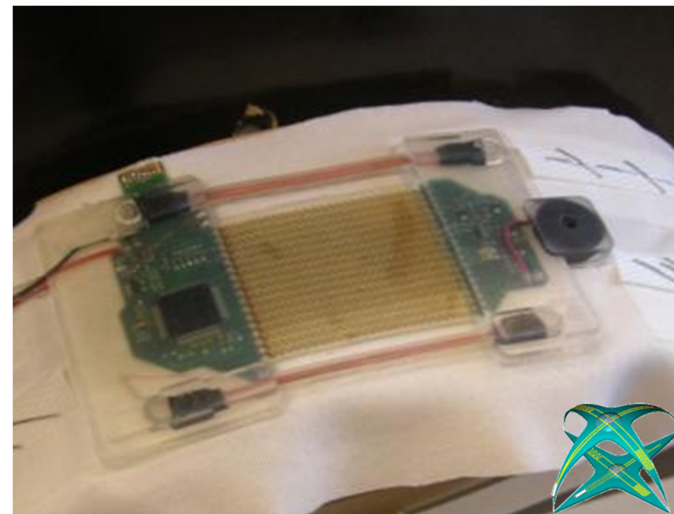
Principle of stretchable interconnections



STRETCHABLE MOULDED INTERCONNECT

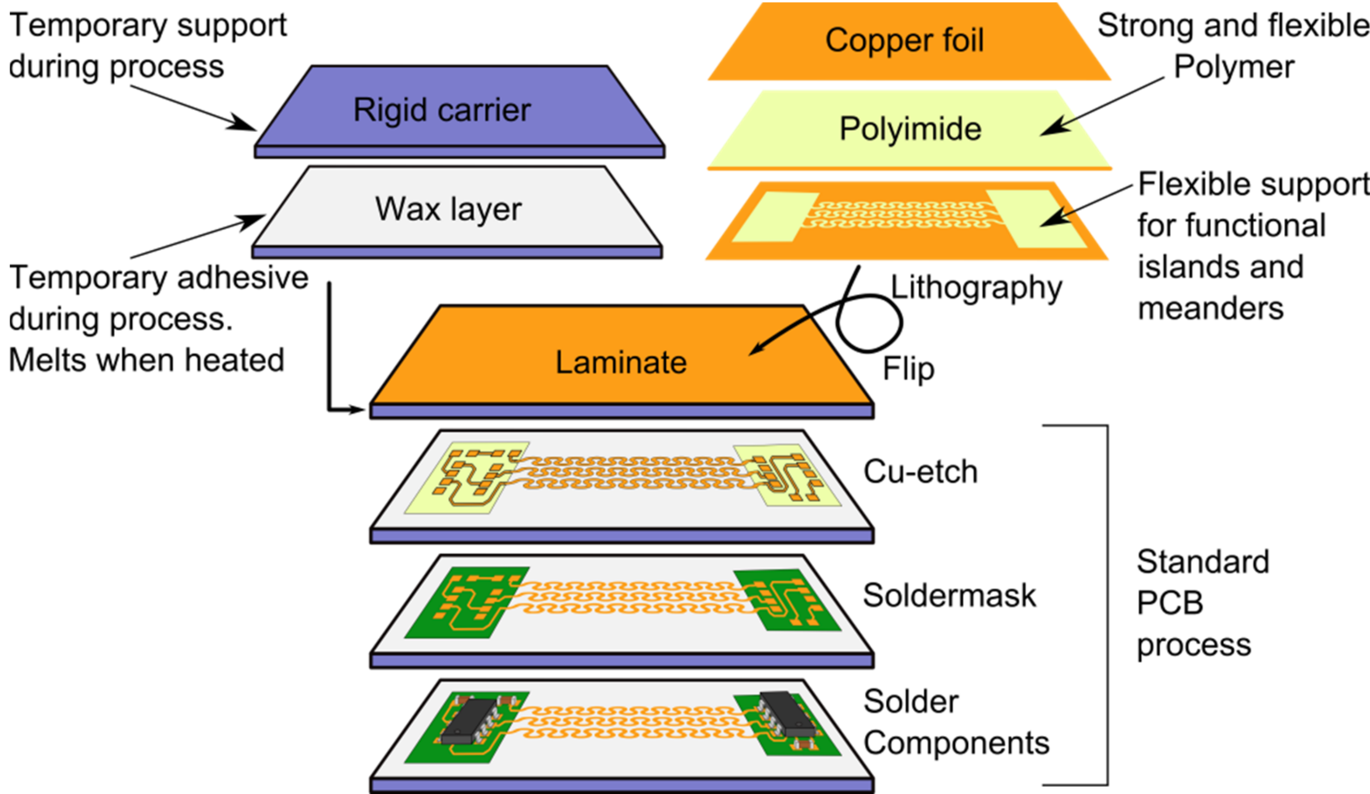






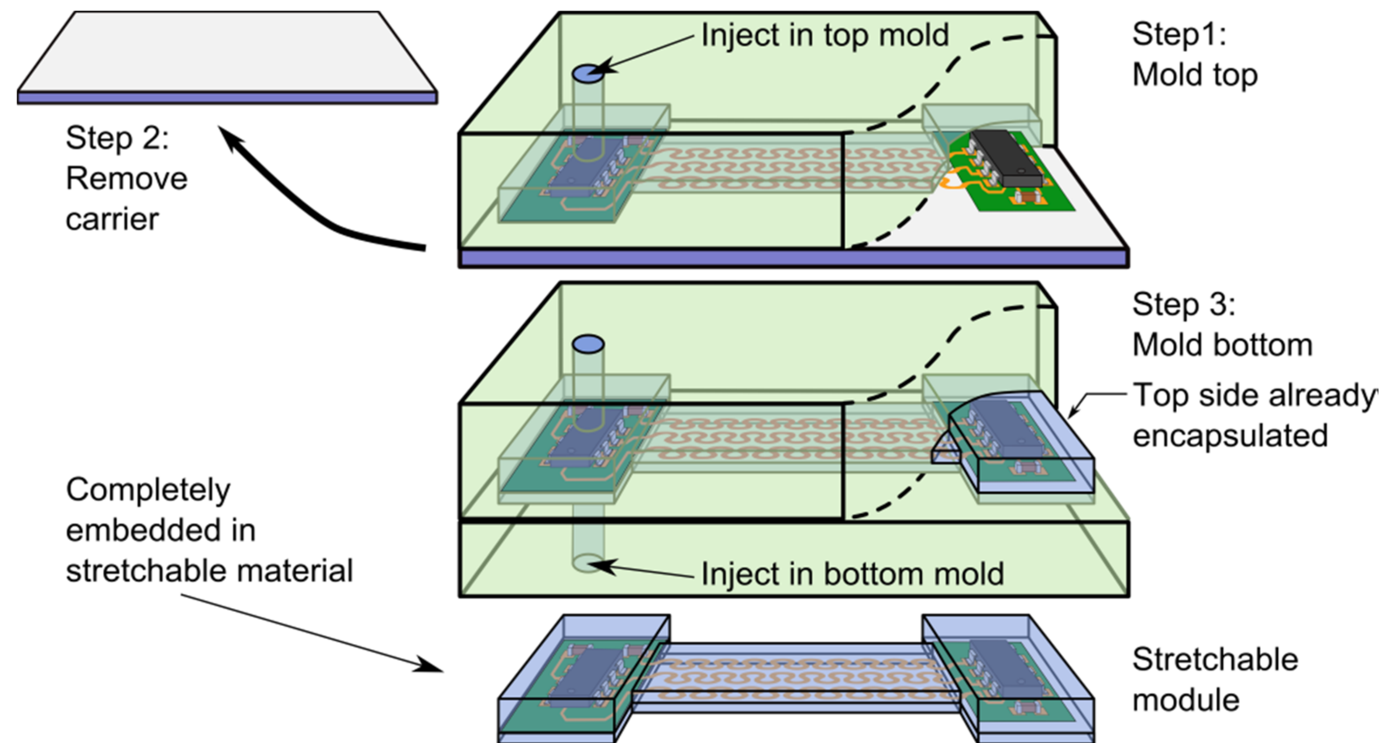
STRETCHABLE MOULDED INTERCONNECT

SMI Process flow – part 1



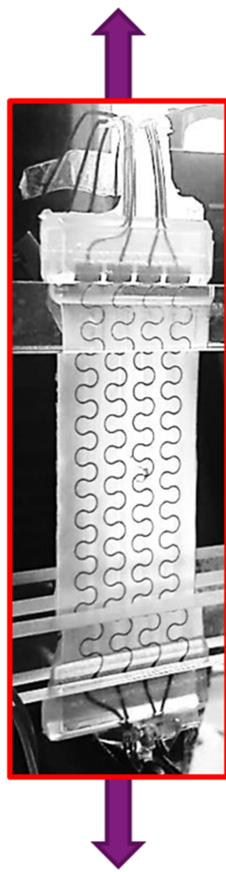
STRETCHABLE MOULDED INTERCONNECT

SMI Process flow – part 2



STRETCHABLE MOULDED INTERCONNECT

Cyclic endurance testing of meanders



Endurance of stretchable interconnects developed on different substrate films encapsulated in PDMS

50um PI cladding w.17um copper

PDMS torn

PDMS torn

50um PET/PEN films

125 um PET/PEN & PC1025

Unsupported 17um copper

Total Elongation [%]

0, 10, 20, 30, 40, 50, 60, 70

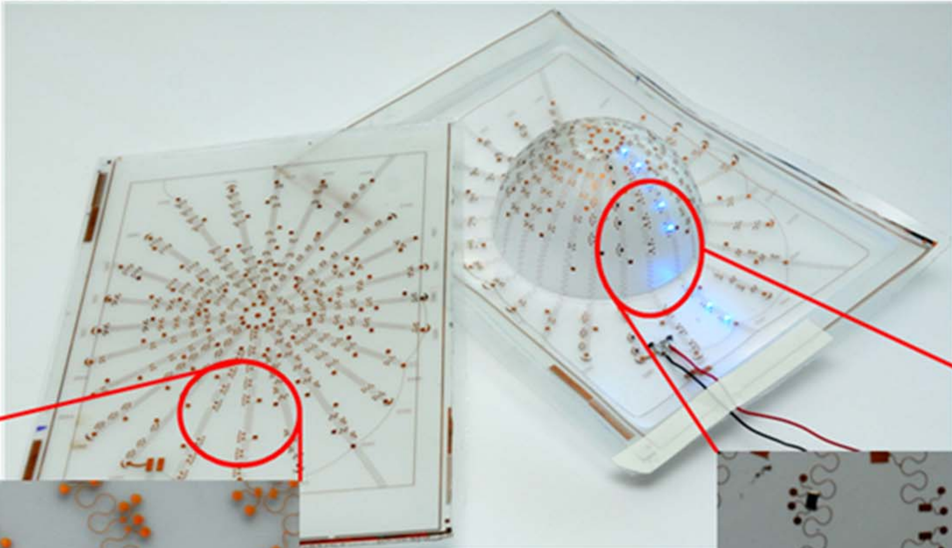
10, 100, 1000, 10000, 100000

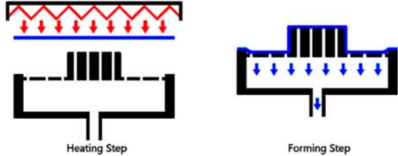
Number of cycles

STRETCHABLE MOULDED INTERCONNECT

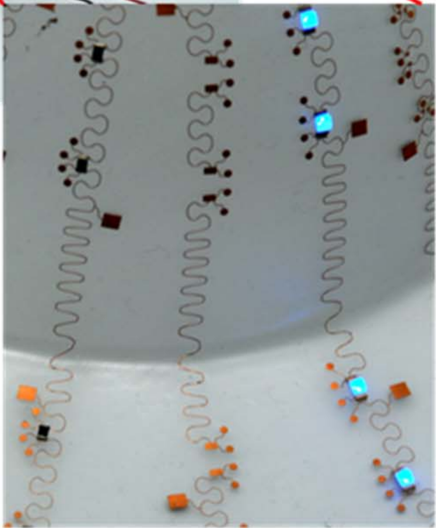
One-time deformable applications

Manufacturing on flat substrates





Deformation into final 3D shape



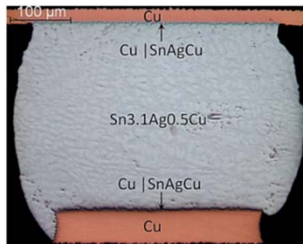
RELEVANCE FOR SPACE APPLICATIONS

Reduction in size and weight by miniaturization and circuit deformability

Reliability is not proven, but promising

- Embedded UTCP as true solderless interconnection
- Stretchable interconnections to absorb shock and vibrations

Hokka, 2013



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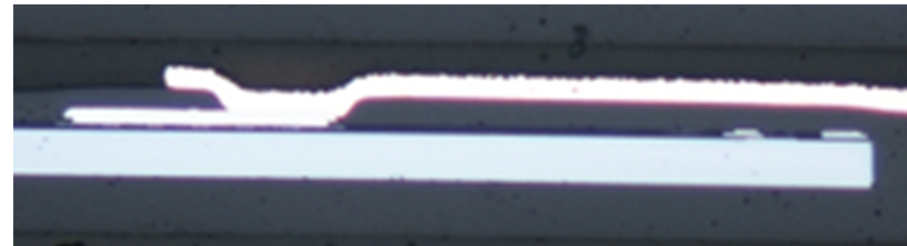

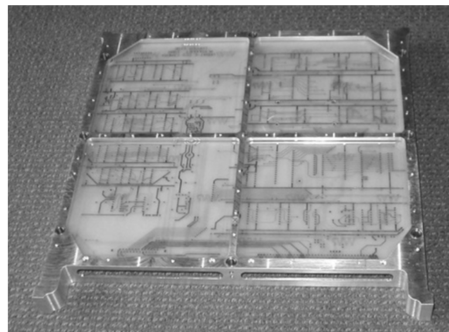

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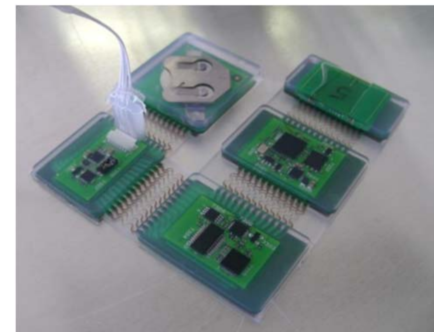

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CONCLUSION

Two emerging technologies for flexible packaging and stretchable interconnections

- UTCP technology makes it possible to realize chip packages with a total thickness of less than 100 µm.
- Stretchable interconnections in the form of encapsulated meanders can survive tens of thousands of stretching cycles of up to 10 % elongation.

Benefits for space applications

- New form factors with increased functional density
- Potentially improved reliability in harsh environments

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