

## Long term and cryogenic endurance of FPC interconnection approaches

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### Motivation

- Flexible printed circuits (FPC) are widely used in various applications ranging from solely replacing cables up to advanced sensing systems with integrated circuits inside the FPC foil
- Wide dimensional range from extremely small as e.g. in medical implants up to several meters long, as e.g. in space vehicles
- Often, FPCs need to be electrically connected to each other or to a rigid structure with appropriate contact pads.
- What kind of substrate material and which interconnection technology is suited best for extremely harsh conditions?
- Need for endurance investigations of different approaches to create such mechanical and electrical interconnections.

### Approaches

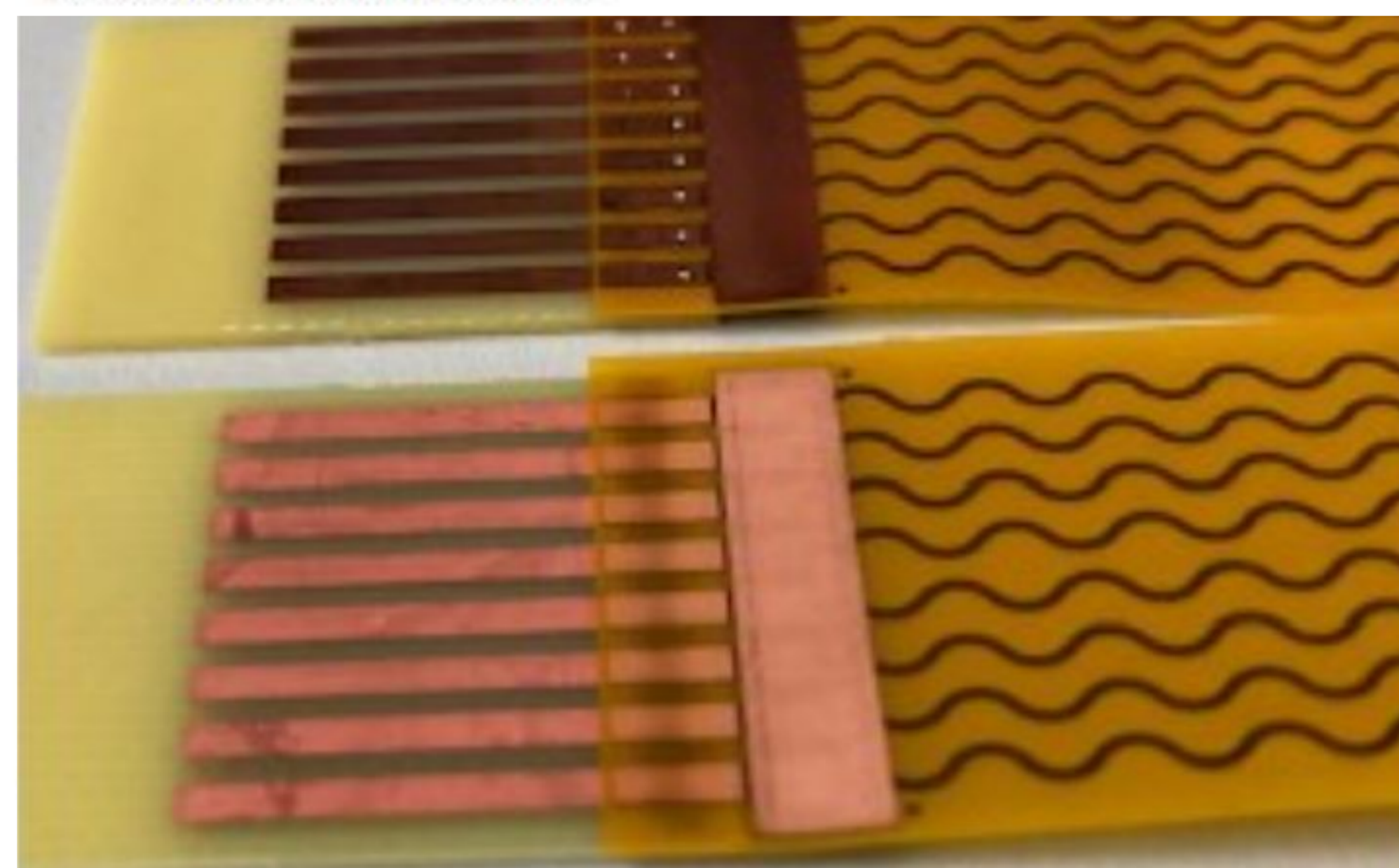
- **Polyimide (PI)** and **polyethylenimine (PEI)** foils as **substrates** for eight parallel copper tracks along these FPCs
- Copper contact pads at both ends of the FPCs
- a) **FPC-FPC interconnection**: Two FPCs connected by placing contact area of one of them upside down to the contact area of the other FPC
- b) **FPC-rigid structure interconnection**: FPC interconnected to a rigid structure represented by a conventional PCB with copper contact pads
- Mechanical and electrical joining approaches: 1. Soldering; 2. Wedge bonding; 3. Isotropically conductive adhesive (ICA); 4. Anisotropically conductive adhesive (ACA); 5. Anisotropically conductive film (ACF); 6. NanoWiring

### Results

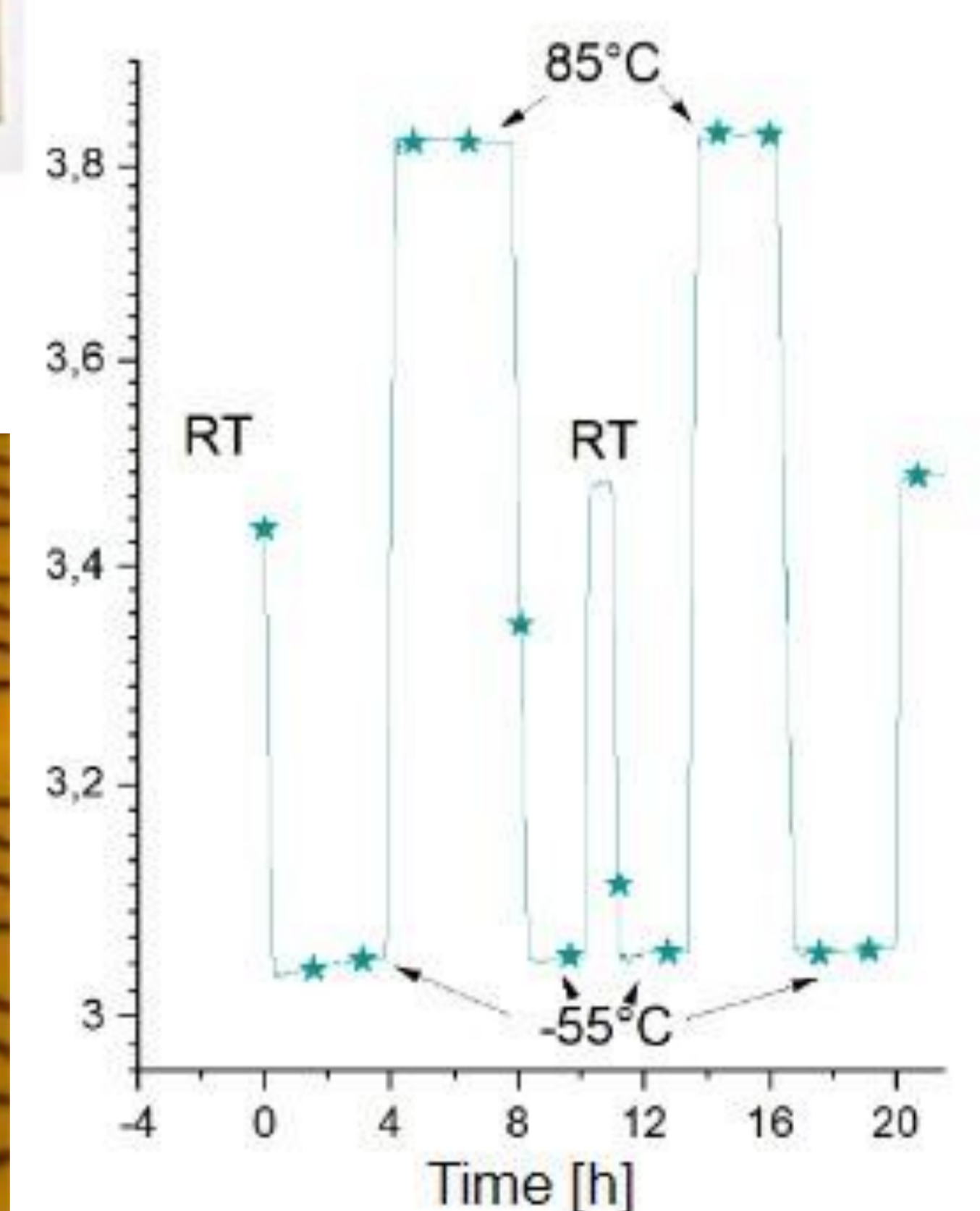
- Wedge bonding failed (attributed to elastic nature of foil materials) → not further tested
- **> 650 fast thermo cycles** from **-55 °C to +85 °C** with all samples: only 3 contact failures (all on one and the same ACF test coupon)
- **5000 hours** climate ageing at **70 °C, 85 % rH**: no failure of any contact
- Cryogenic temperature cycling for approx. 6 months including **5045 cycles** from **-170 °C to +130 °C**: Except for three individual electrical contacts, all samples passed; exception: PEI substrate: all contacts failed - attributed to PEI brittleness at cryogenic temperatures



Eight parallel copper tracks connecting the contact pads at the left and right end of the FPC. Two FPC have been connected.



FPC (right) connected to a rigid PCB (left) before (bottom) and after (top) ageing in climate chamber.



Example of electrical resistance over two connected FPC during temperature cycling.

### Conclusions

- “Standard” interconnection technologies provide **stable electrical / mechanical contacts** also for harsh environmental conditions as required by the aerospace industry.
- Performance at **cryogenic temperature**, as an even more demanding application scenario, necessitates the appropriate selection of a suitable substrate material.

### Acknowledgements

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