AIRBUS

Central Research and Technology

J.A.M.E.S

LOPEC 2024

Session Functional materials

Durability investigations of 3D printed electronics towards aeronautic-inspired environmental loads

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Motivation

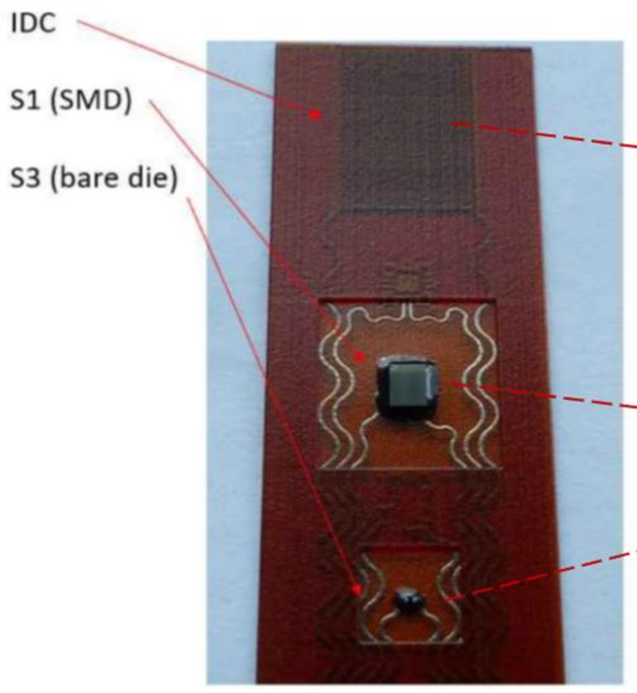
- Additively Manufactured Electronics (AME) enables electronic fabrication through 3D printing techniques
- Fully 3-dimensional electronics by processing conductive and non-conductive material and building up complex structures layer by layer
- Enabling additional design possibilities ⇒ higher integration density, smoother RF transitions, less usage of raw material and harmful chemicals
- Limited information on durability of AME structures ⇒ test structures created to evaluate AME without additional protective housings for potential harsh aeronautic applications

Approach

- Test samples printed with Nano Dimensions DragonFly:
- 250 µm thick dielectric base layer
- Silver ink to create 18 µm thick conductive tracks and IDC (interdigital capacitor) with 125 µm lines/spaces
- 250 µm thick dielectric cover with cutouts
- Integration of 230 µm thick SMD (surface mounted device) by soldering with bismuth at 180 °C and 250 µm thick silicon bare die using ACA (anisotropic conductive adhesive)
- Dispensing a drop of globetop for device protection

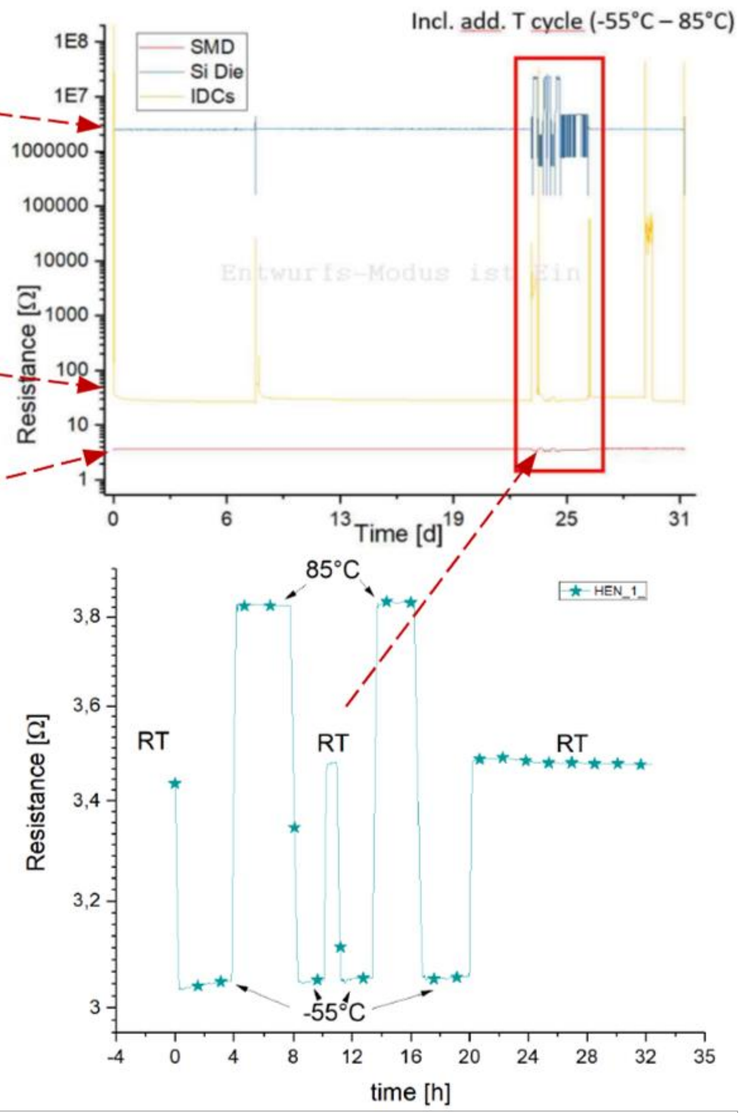
Results

- SMDs and bare dies are test devices with defined ohmic resistance.
- Fluid immersion for 14 days: a) kerosene, b) Skydrol hydraulic fluid, c) de-icing fluid: **all samples stable** in all three service chemicals; **no optical degradation**; high electrical resistance of bare die in Skydrol
- -55 °C to RT and +85 °C temperature cycling: **stable signal from SMD** but high resistance and **fluctuations for bare die**
- Ageing in climate chamber (70 °C, 85 % rH) for 32 days: **high electrical resistance for bare dies, stable signals for SMD**
- Results indicate **issues with ACA** but **high stability for SMD**; **no degradation of material system** showing **high potential of AME in harsh environments**
- Future work recommended to reduce brittleness



AME printed PCB with hybrid integrated SMD and bare die.

Test example: temperature cycling



Acknowledgements

We highly appreciate the support of **Joao Marques** from **Fraunhofer IZM** in the assembly process.

Abstract number: 100874

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