

SHIP- Printed Hybrid Electronics (SHIP-PHE)

Heterogeneous 3D

Research Efforts

Develop advanced additive manufacturing methods for the fabrication of electronic circuits onto conformal, non-flat surfaces.

- "Print what you can, place what you can't"

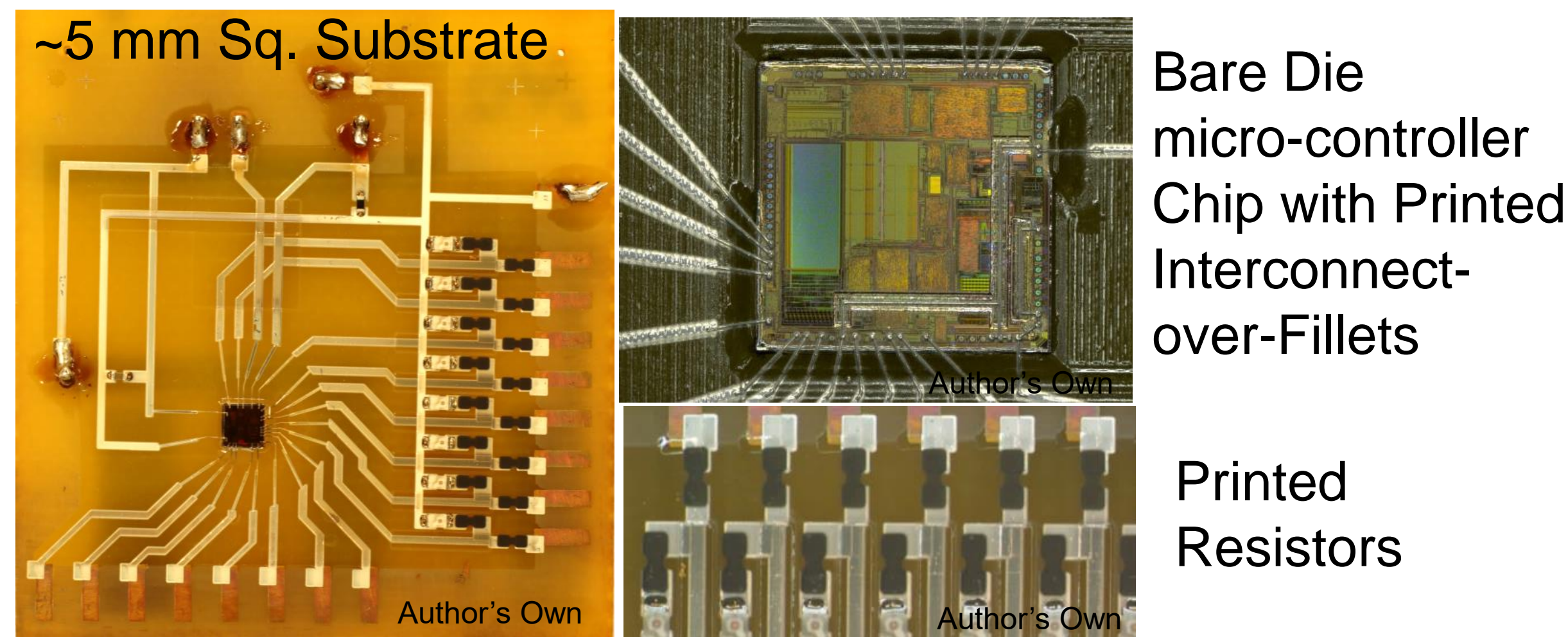
Examples of PHE Components

Components	Standard	PHE
Integrated Circuit Packaged / Bare Die		
Resistor Surface Mounted / Printed		
Capacitor Surface Mounted / Si based bare die		

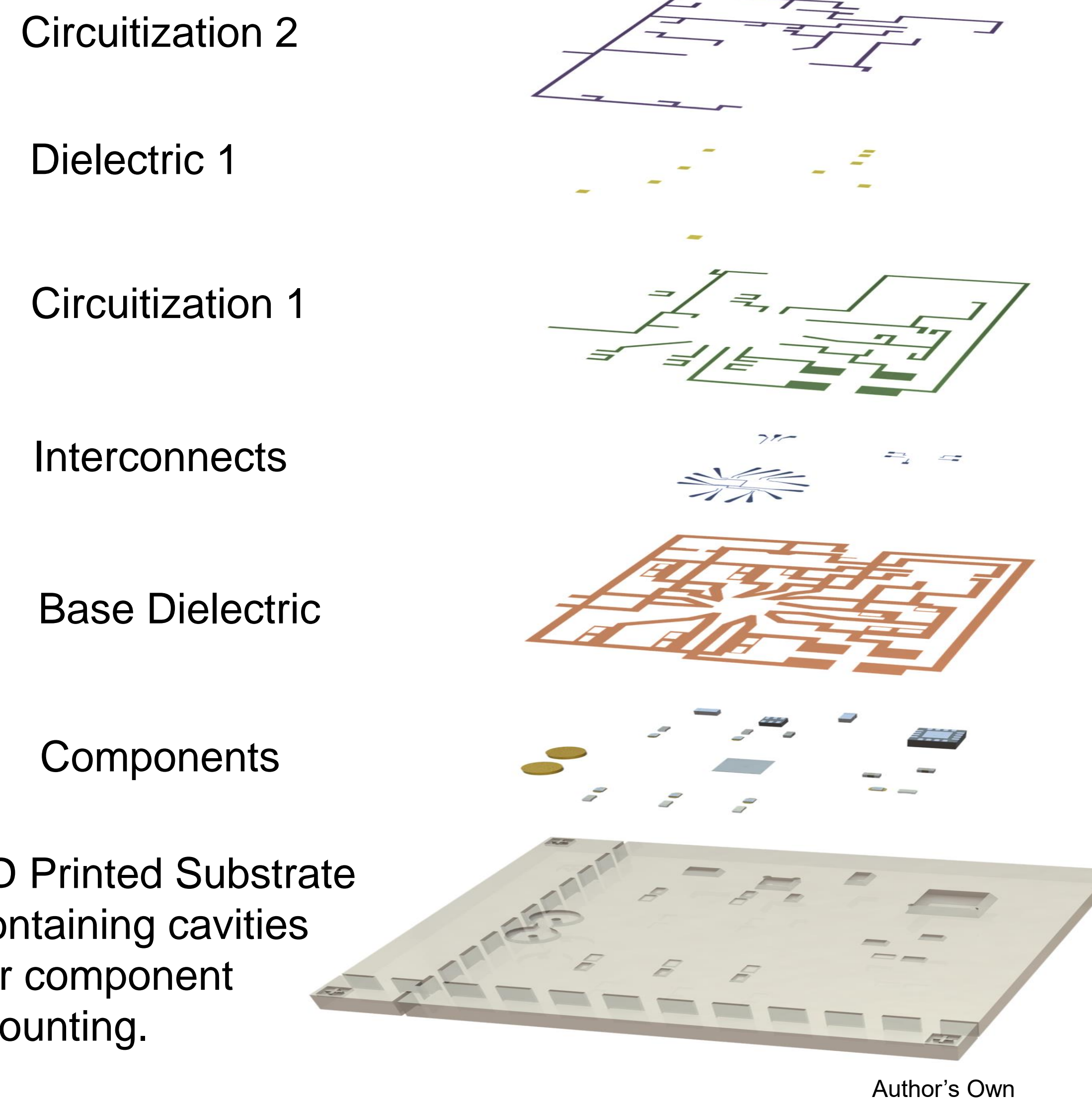
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Tech Transitions and Production Efforts

1st Generation PHE Micro-Controller Circuit Prototype:



2nd Generation PHE 'Arduino' Circuit Based on the NextFlex (same chip set) Flex 'Arduino' Circuit:



Process Methods

1. 3D Print substrate using FormLabs SLA printer.
2. Automated Pick-and-Place into component cavities with BESE tool.
3. Aerosol-Jet Print Fillets and Moat Fills.[†]
4. Aerosol-Jet Print Dielectric, Interconnect and Circuitization Layers.

[†] Gu et al., Adv. Mat. Tech., Vol. 2, Iss. 11 (2017).

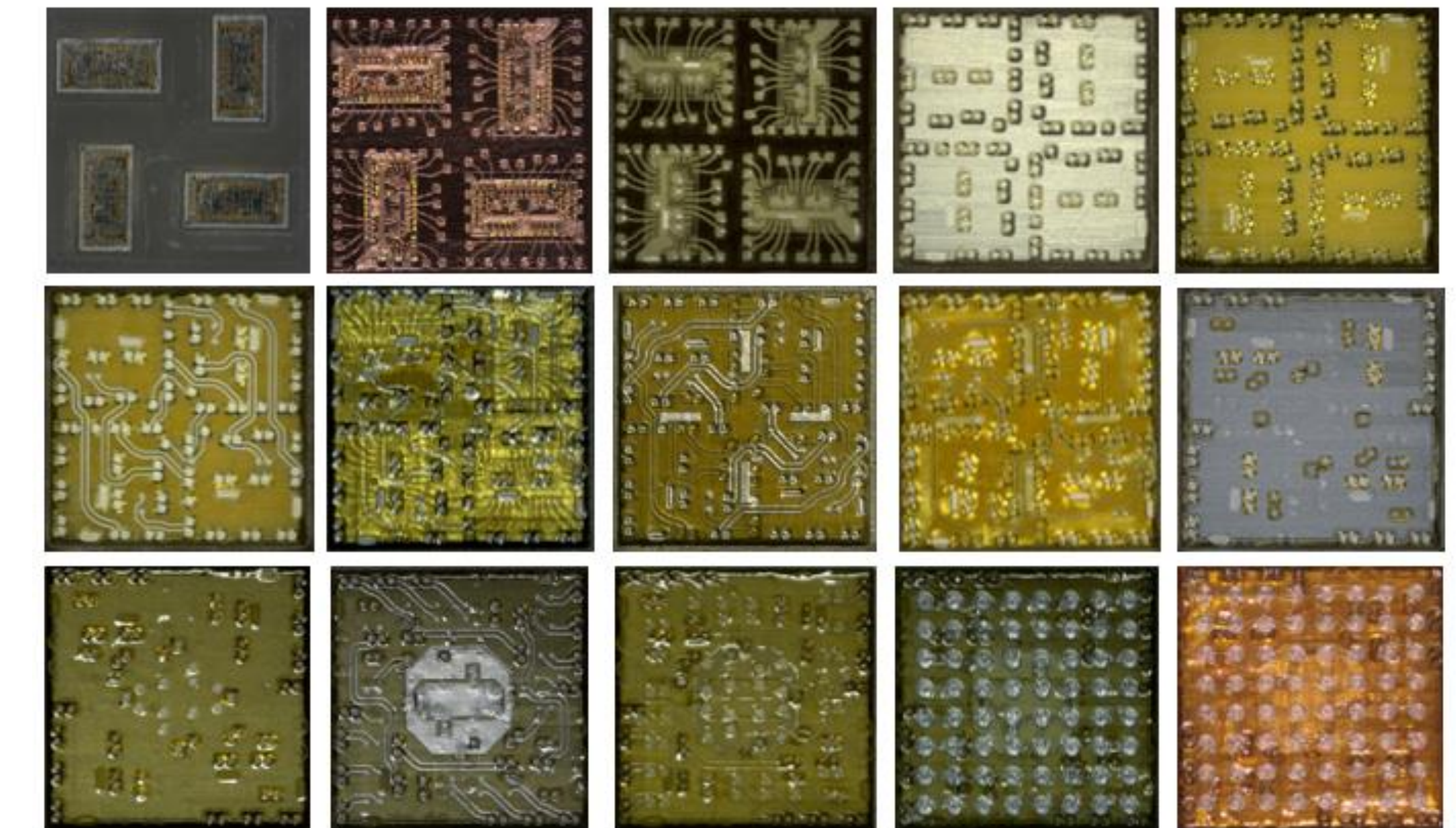
SHIP-PHE Goals:

- Mature Production Team Capabilities.
- Create full Manufacturing protocols.
- Fabricate 30 fully working PHE Arduino type Circuits.
- Perform full HTOL and Temperature cycling reliability testing.

Overall Goal is to have a fully qualified PHE Manufacturing Capability.

Future Work – In Development:

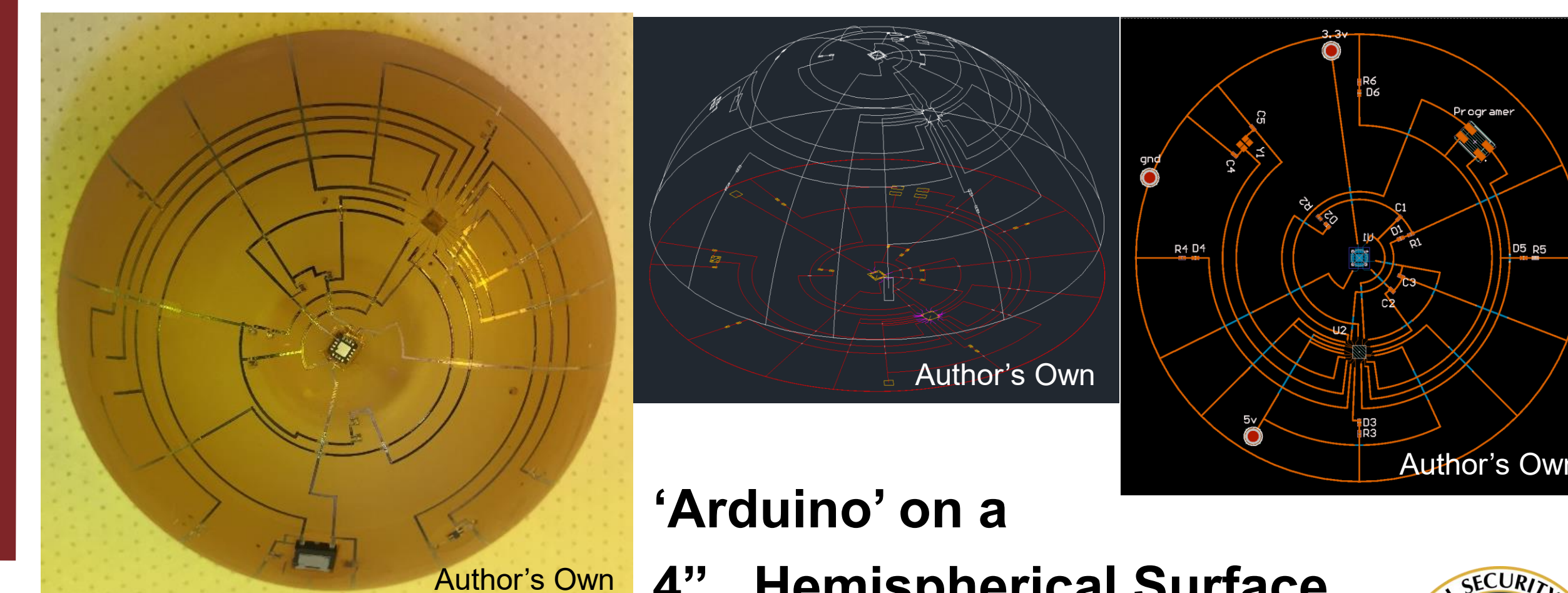
4 Chip Module (MCM) - 4.3 Sq. mm with 14 AJ printed sub-layers for Redistribution Layer



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Printing & Processing Requirements:

- < 1 Hour Printing + Processing time per Layer.
- Compatible with Reflow Oven Processing Temperatures or Lower.
- Resistivity < 4x Bulk Ag (6×10^{-8} Wm)

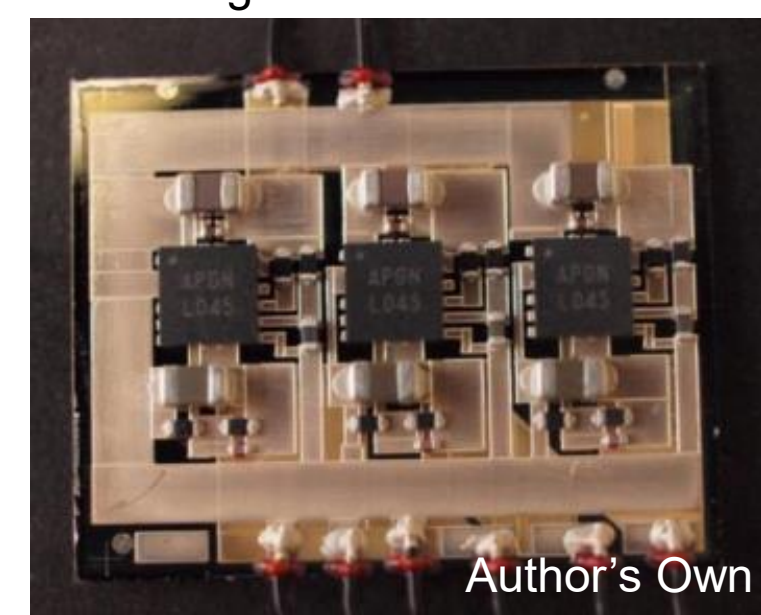
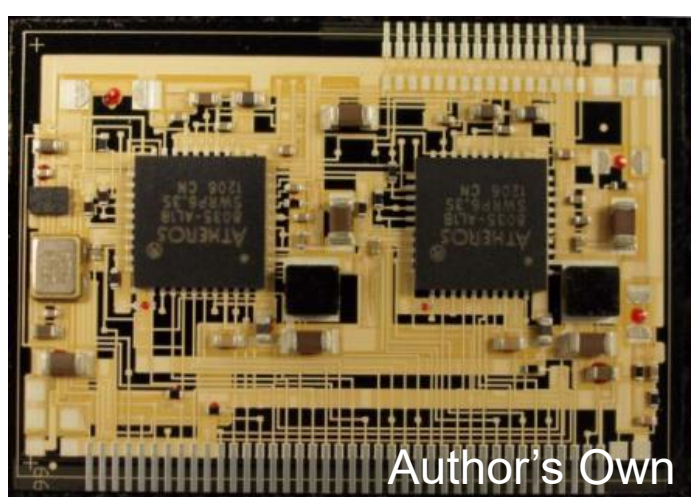


'Arduino' on a 4" Hemispherical Surface

Examples of Printed Circuitization:

- Power Supply - 5 V, 1 Amp Input full reliability tested, performance on par with comparable Cu/FR4 version.

~(17 x 25) mm

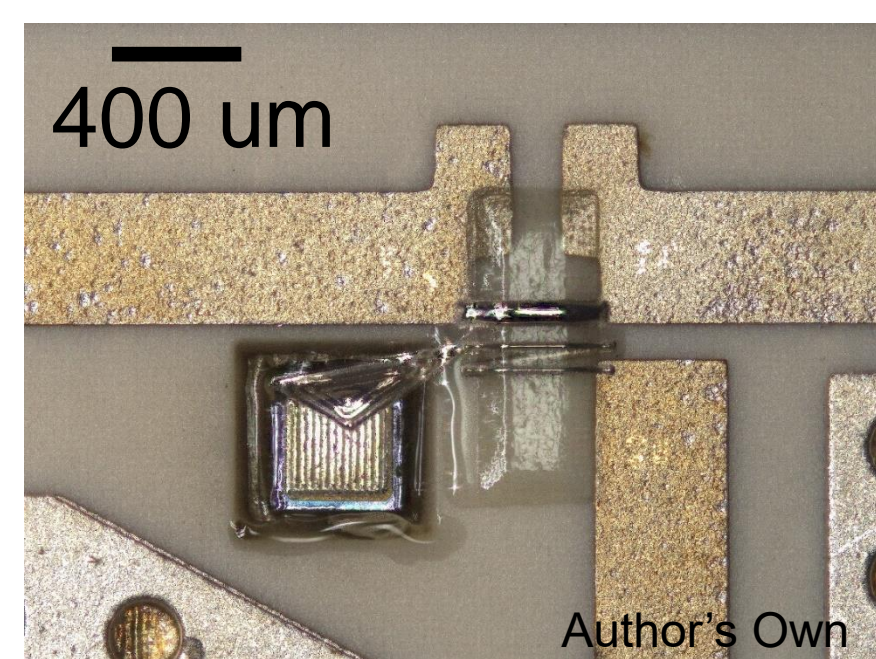


~(15 x 20) mm

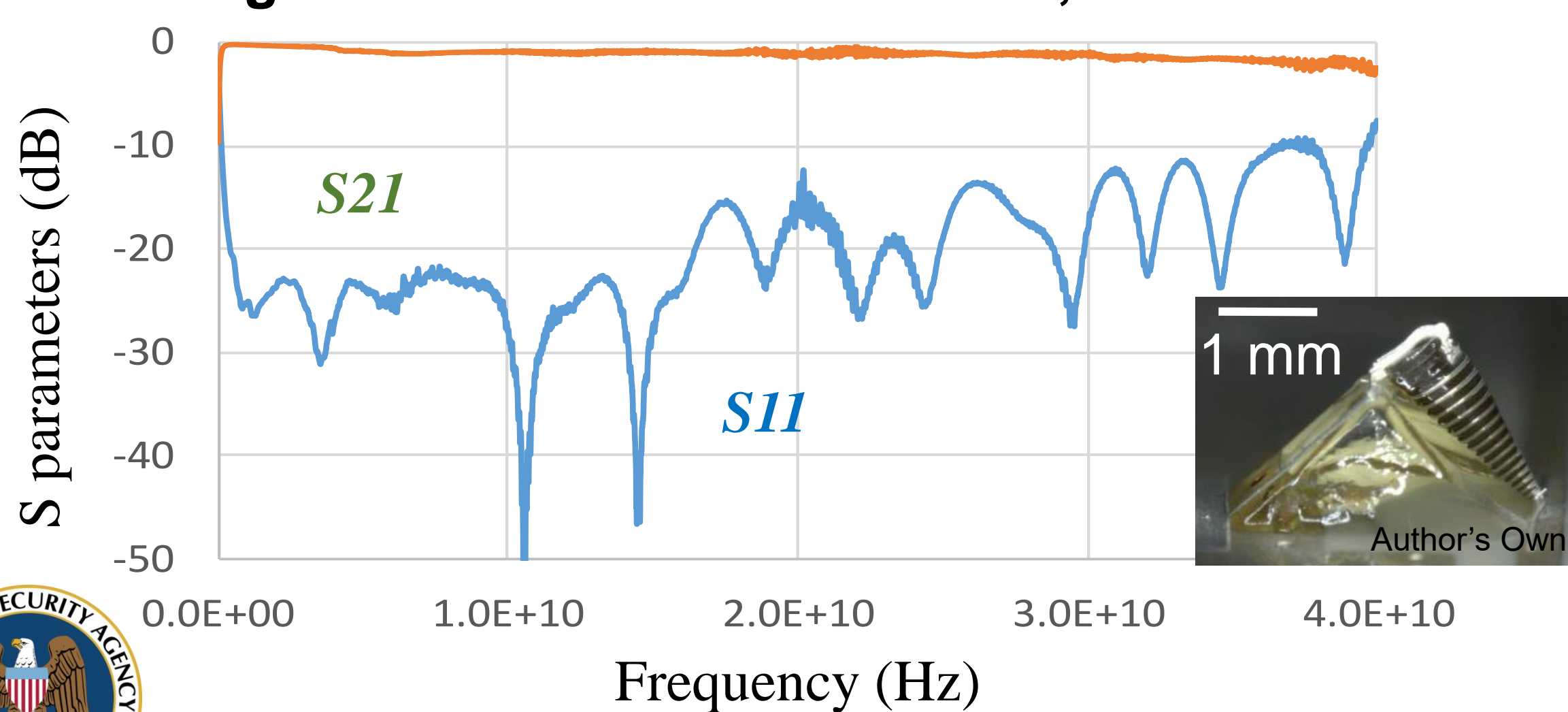
- Digital Interface Circuit: demonstrated Gbit data rates.

Examples of Printed RF Components:

- 3-Port RF Transformer.
- Printed RF, Iron Core Inductor



Scattering Parameters – AJ Fabricated, Iron-core Inductor



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