Direct-Write Printing on Three-Dimensional Geometries for Miniaturized Detector and Electronic Assemblies
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OBJECTIVES
- Define a repeatable process for printing the following applications:
  - Next Generation X-Ray Polarimeter Detector Strips
  - Next Generation Microshutter Arrays
  - MicroWell Detectors
  - Magnetometer Bobbin Wires

APPLICATIONS

Next Generation X-Ray Polarimeter:
- Detector Strip Pattern on 3D Surface using AJP
- 3 in x 5 in Liquid Crystal Polymer Substrate
- Fan-out area
- 90-degree bend
- Rigid ASIC Board

Detector Strip: Original Design 60µm width traces with 121µm pitch

Next Generation Micro Shutter Arrays (NGMSAs)
- Test print: Silver Traces Printed onto MSA Substrate and Metal Pads with insulator in between
- Printed Insulator

Microshutter array (MSA) test prints completed. Conductivity tests showed promising results.

FUTURE WORK
- Test printed detector strip patterns on rigid pre-formed material.
- Print wires around magnetometer bobbins.
- Print traces for CubeSat flex circuitry.
- Print insulating fillets around chips and print interconnects to those chips using defined alignment and CAD adjustment procedures for Silicon Microwell detector (SiMWD) assemblies.
- Print ASIC board pattern onto detector strip block, attach ASIC and print its interconnects.

KEY CHALLENGES
- Enable new detector and electronic assemblies:
  - Reduces trace widths and other feature sizes to 10 microns from the current trace sizes, which increases sensitivity by an order of magnitude;
  - Enables dense assemblies - require trace spacing of 121 microns or less;
  - Permits very complex geometries on flexible and three-dimensional substrates.
  - Reduces Assembly Time – MWDs for example require thousands of interconnects that would typically be wire bonded.

FINDINGS AND STATUS
- Completed Repeatability Plans for all 4 applications.
- Completed Material Selection for all 4 applications.
- Designed rigid substrates for 3D rigid detector strip and magnetometer bobbin. Defined 3D printing paths.
- Additional application of superconducting traces identified.
- Additional application of flex cable for CubeSat identified.
- Received all substrates.
- Prints of detector strip pattern on rigid and flexible materials completed.
- Microshutter array (MSA) test prints completed. Conductivity tests showed promising results.
- Wire bond tests on the detector strip prints on PEEK showed that gold bonds adhere better.

APPLICATIONS

Ink Jet vs Aerosol Jet Printing

Optomec Aerosol Jet Printer AJ200

Optical images of Microshutter

MSA Original Design
80µm pitch Pads, 100µm MSA height
(from substrate surface to top surface of array)

Printed Silver Lines
Metal Pads
Printed Insulator

Test print: Silver Traces Printed onto MSA Substrate and Metal Pads

(Left) MWD interconnects from the tile edges to substrate, (right) interconnects between MWD tiles. The goals of this program are to add insulating fillets (not shown) between the tiles and substrate and possibly also between tiles, and to replace the wire bonds illustrated here with 3D printed conductive traces

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