Opportunity Title: Advancing direct-write printing methods for the fabrication of electronics on complex surfaces
Opportunity Reference Code: IC-17-21

Organization Office of the Director of National Intelligence (ODNI)

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Complete your application – Enter the rest of the information required for the IC Postdoc Program Research Opportunity. The application itself contains detailed instructions for each one of these components: availability, citizenship, transcripts, dissertation abstract, publication and presentation plan, and information about your Research Advisor co-applicant.

Application Deadline 3/31/2017 11:59:00 PM Eastern Time Zone

Description **Research Topic Description, including Problem Statement**:

Aerosol-jet printing methods have been utilized to successfully fabricate multi-layer circuits of which the power supply (PS), digital interface (DI) circuit and electrical ball grid array (BGA) connections for IC chips, all shown in Figure 1, are a few examples. Both the PS and BGA parts have gone through extensive accelerated life-time testing and have been shown to work on-par with the conventional electronics parts from which they were modeled. In fact, the BGA parts have displayed very robust performance and the DI circuit has been demonstrated to be fully functional at GB data rates.
However, limitations associated with the fabrication of these circuits are related to (a) the need for thermal processing up to 250 °C, (b) fabrication onto flat surfaces and (c) electronic components that are surface mounted after fabrication of the circuit.

Unclassified Example Approaches:

In order to overcome these limitations and advance fabrication capabilities, the following topics could be investigated;

- Identify and characterize ink materials that can be processed at temperatures below 150 °C without loss in performance,
- develop printing methods for the fabrication of circuits onto non-flat, 3D printed surfaces, and
- develop methods for integrating/embedding components into these circuits during fabrication (Fig. 1d illustrates a first attempt at integrating the capacitors into the substrate for the PS circuit).

Link below contains reference images

http://orise.orau.gov/sepreview/ic/ic1721.pdf.

Figure 1: Images of direct-write printed circuits (a) power supply, (b) digital interface, (c) ball grid array, (d) power supply on capacitor substrate.

Direct-write printing of electronic circuits onto complex surfaces for

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production level fabrication of 3D printed hybrid electronics will require multiple capability advancements. Some areas that could be explored are:
1. Design capabilities based on additive manufacturing methods that can automatically generate printable toolpaths requiring minimal manual intervention,
2. Materials sets formulated for specific functionality, printability and processability that are compatible with low temperature substrates and components,
3. Tool platforms that can accept the specified toolpaths (see 1) and enable printing of the above materials sets (see 2) onto 3D surfaces,
4. Improved processing/printing capabilities that can combine advancements in areas 1, 2 and 3 in order to fabricate the desired electronic circuits and
5. Accelerated life-time testing and analysis to verify that the fabricated electronics can function as required in real world settings. The primary research topic related to this proposal is the development of successful methodologies for integrating/embedding electronic components and the printing of conductors, dielectrics and polymers onto 3D printed, non-flat surfaces.

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Business** (11 👁)
  - **Chemistry and Materials Sciences** (12 👁)
  - **Communications and Graphics Design** (6 👁)
  - **Computer, Information, and Data Sciences** (16 👁)
  - **Earth and Geosciences** (21 👁)
  - **Engineering** (27 👁)
  - **Environmental and Marine Sciences** (14 👁)
  - **Life Health and Medical Sciences** (45 👁)
  - **Mathematics and Statistics** (10 👁)
  - **Other Non-Science & Engineering** (13 👁)
  - **Physics** (16 👁)
  - **Science & Engineering-related** (1 👁)
  - **Social and Behavioral Sciences** (28 👁)