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Opportunity Title: Machine Led Discovery of Electrically Functional Materials for Additive Manufacturing
Opportunity Reference Code: ICPD-2022-39

ORISE

Organization Office of the Director of National Intelligence (ODNI)

Reference Code ICPD-2022-39

How to Apply

Create and release your Profile on Zintellect – Postdoctoral applicants must create an account and complete a profile in the on-line application system. **Please note: your resume/CV may not exceed 2 pages.**

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.

Additional information about the IC Postdoctoral Research Fellowship Program is available on the program website located at: https://orise.orau.gov/icpostdoc/index.html.

If you have questions, send an email to ICPostdoc@orau.org. Please include the reference code for this opportunity in your email.

Application Deadline 2/28/2022 6:00:00 PM Eastern Time Zone

Description

Research Topic Description, including Problem Statement:

Additively manufactured electronics, printed electronics, 3D electronics, flexible electronics and wearable electronics is a fast-growing market. It permits a move away from the wet chemistry processes which are energy intensive, labor intensive, plant equipment intensive, uses hazardous chemicals and produces significant waste streams with associated environmental disposal concerns.

This topic is focused on electrically functional materials which are required for fabricating a wide range of products cheaply and quickly with considerable geometrical complexity at low production quantities.

These electrically functional materials are required in several forms such as printable adhesives, printable inks or as bulk printable material, and must be capable of being printed using commonly available commercial process equipment such as UV Objet, Dragonfly, aerosol jet and piezoelectric nozzles, etc.

The current generation of printable electrically functional materials have several issues:

- Currently in the commercial market there are very few printable electrically conducting adhesives, conducting inks or dielectric inks that can match the electrical, thermal and mechanical performance of conventional metallurgical solders or bulk materials.
- Very few electrically functional inks can match the performance of or replace conventional surface mount passive components (such as resistors, capacitors and inductors) **and** be capable of being cured or sintered using typical processes such as UV lamps or IR heat sources commonly found on AM/AME printing equipment.

Thus it is challenging to move away from using wet chemistry based PCB fabrication, SMD components and the associated common bonding processes such as solder reflow.

To investigate new adhesives, inks and materials would take too long using conventional materials sciences in terms of discovery, screening, time consuming & labor intensive. The materials science space is too large & difficult to navigate quickly and efficiently.

The aim of this research topic is to encourage proposal submissions that use machine learning, artificial intelligence, neural networks and any other computational technique(s) to rapidly accelerate the discovery of candidate adhesives, inks and materials. The promising materials would then need to be screened to produce a shortlist of viable electrically functional materials.

Example Approaches:

- Focus on the fundamentals of improving printable electrically functional materials such that their performance is nominally similar as that encountered in conventional assembled PCBs for a wide range of electrical, mechanical, thermal, and bonding properties.
- Focus on reducing the time and effort required to identify and screen potential candidate materials while keeping an eye on its compatibility with existing processes commonly found within AM & AME printers.
- The author is materials class agnostic, so it is acceptable to search for materials that are electrically conductive but are not metallurgical but have similar electrical properties to that of bulk copper, silver or gold for example but can be printed and cured/sintered using existing curing/sintering processes commonly found in AM & AME printers.
- Similarly, when looking for high dielectric constant materials, are there any others that are better than barium titanate, it does not need to be restricted to ceramics only.
- Develop a computational framework and materials dataset to aid future down selection of printable electrically functional materials.

Relevance to the Intelligence Community:

The ability to print fully assembled PCBs on a printer in a 3D geometrically complex shape would allow us to move away from the planar 2D limitations inherent in conventional PCB fabrication. An ECAD file generated elsewhere can be sent to a printer over the internet. With an improved range of electrically functional materials at its disposal, custom fullyelectricallyfunctional3DPCBswouldbetheoutputoftheprinter.

This allows the IC to be less reliant on full scale manufacturing capabilities, creating a mobile one stop shop for both prototyping and small production quantity runs of geometrically complex 3D electrically functional PCBs. This will also give the ability to be more responsive and agile to print of custom electronics meeting very specific and custom customer requirements.

Key Words: Electrically functional Adhesives, Electrically Functional Inks, Electrically Functional Materials, Machine Learning, Artificial Intelligence, Neural Networks, AME, Additive Manufactured Electronics. PCBS, Printed Circuit Boards, 3D Electronics, Printed Electronics, Roll to Roll, Adhesive, Ink, Electronic Material, Resistor, Resistivity, Capacitor, Capacitance,Semiconductor, Inductance. Inductor, Magnetic, Ferroelectric, Conductor, Conductivity, Piezoelectric, Piezoelectricity, Photovoltaic, Solar, Electromagnetic, Thermoelectric, Triboelectric, Antennas, Power Harvesting, RFID, Flexible Electronics, Wearable Electronics

Qualifications

Postdoc Eligibility

- U.S. citizens only
- Ph.D. in a relevant field must be completed before beginning the appointment and within five years of the application deadline
- Proposal must be associated with an accredited U.S. university, college, or U.S. government laboratory
- Eligible candidates may only receive one award from the IC Postdoctoral Research Fellowship Program

Research Advisor Eligibility

- Must be an employee of an accredited U.S. university, college or U.S. government laboratory
- Are not required to be U.S. citizens

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12)
  - **Communications and Graphics Design** (2)
  - **Computer, Information, and Data Sciences** (16)
  - **Earth and Geosciences** (21)

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- **Engineering** (27)
- **Environmental and Marine Sciences** (14)
- **Life Health and Medical Sciences** (45)
- **Mathematics and Statistics** (10)
- **Other Non-Science & Engineering** (2)
- **Physics** (16)
- **Science & Engineering-related** (1)
- **Social and Behavioral Sciences** (27)