RX15-1

1. **Research Title:** Structure-Property Relationships of Block-Copolymer Dielectrics Prepared by Additive Processing
2. **Individual Sponsor:** List the AFRL research topic sponsor's contact information

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3. **Academic Area/Field and Education Level**

Materials Science & Engineering, Chemical Engineering, Chemistry, Physics, Electrical Engineering, or related fields (M.S. or Ph.D. level)

4. **Objectives:** Develop solution/ink formulations of block-copolymers and/or polymer nanocomposites compatible with drop-on-demand additive manufacturing techniques (e.g., inkjet, aerosol jet, micro-dispensing, or eletrohydrodynamic deposition) and investigate how processing parameters (e.g., droplet size, solution chemistry/composition, and layering) affect film morphology and ultimately capacitor performance. Understanding process variability as well as the role of film morphology, defects, and interfaces in dielectric performance is critical for enabling printing of capacitors.
5. **Description:** Drop-on demand digital manufacturing is capable of rapidly producing electronic components (e.g., sensors, capacitors, electrode patterns, batteries, radio-frequency identification tags) tailored to a variety of applications. Ordered block co-polymer films are desirable as a dielectric material in capacitors that require high breakdown strength, and in such films it has been shown that careful control of processing conditions is necessary to produce highly ordered polymer morphologies. It is unclear how the morphology and dielectric breakdown strength of such films will be affected by additive drop-on demand techniques or how additive methods could be used to creatively achieve morphologies not observed in traditional processing methods (e.g., drop casting, spin coatings, etc.)

   In this project, block co-polymer films (or block co-polymer nanocomposite films) will be formulated for a specific drop-on-demand technique, which will then be used to deposit thin dielectric films. Solution chemistry, substrate chemistry, and process parameters (e.g., droplet size, solution chemistry/composition, print pattern, additive layering, etc.) will be varied to determine the effect of such variables on block co-polymer film morphology and ultimately dielectric performance of a capacitor. Of particular interest is an assessment of device variability, including occurrence of defects, when printed using the same parameters. These results will inform additive processing optimization of printed capacitors based on co-polymer dielectrics and contribute to a foundational understanding of causes of non-uniformity in additive device fabrication.

6. **Research Classification/Restrictions:** This research is unrestricted, and the results will be in the public domain.

7. **Eligible Research Institutions:** Indicate to what organizations this topic should be provided

■ **DAGSI** (Wright State University, AFIT, Ohio State University, University of Dayton, Miami University, Ohio University, University of Cincinnati) NOTE: Topics submitted to DAGSI must be approved for public release. **Need PA Approval #**

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