RX15-5

1. **Research Title:** Understanding Structure-Property Relationships of Molecularly Stretchable Organic Electronic Materials
2. **Individual Sponsor:** List the AFRL research topic sponsor's contact information

Matthew J Dalton
AFRL/RXAS
2941 Hobson Way, Rm 337
WPAFB, OH 45433
matthew.dalton.6@us.af.mil

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

   Chemistry, Materials Science & Engineering, Chemical Engineering, or related fields (MS or Ph.D. Level)

4. **Objectives:** Establish, through a synthetic copolymerization approach, an understanding of parameters which can increase the elasticity, toughness, and ductility of conjugated organic polymers. This work should provide further insight into how charge transport and mechanical properties are related to molecular structure and seeks to optimize device performance while increasing mechanical compliance.
5. **Description:** For many organic electronic applications, mechanical degradation is a primary cause of device failure and more elastomeric materials would be beneficial. Typical BHJ solar cell P3HT:PCBM blends fracture at very low tensile strain on elastomeric substrates like PDMS. The back bone conjugation necessary for charge transport inherently increases rigidity in these materials, while solubilizing non-conductive pendant groups necessary for processability tend to have the opposite effect. The length and nature of the pendant groups influence the morphology and tend to impact mechanical properties positively with increasing length but transport negatively. Seemingly, mechanical compliance and charge transport properties display an inverse relationship, but there are reports of both traditional and random segmented block copolymers having a positive effect on mechanical properties while maintaining or even improving charge transport and device performance.

   This project will focus on the design and synthesis of polymers tailored for molecularly stretchable organic electronic applications. Monomers should be explored systematically to examine the effect of side chain nature/length, backbone structural randomness, fused rings, and/or crystallinity, and polymers made from these monomers should be characterized by standard methods (NMR, Uv-Vis, GPC, XRD, etc). To inform the synthetic routes and more fundamentally understand the structure-property-processing relationships, mechanical response (tensile modulus, crack onset strain, etc.) should concurrently be assessed as a function of the processing parameters and morphology and correlated to device performance metrics such as power conversion efficiency (PCE) or field effect mobility.

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 #**

88ABW-2014-3087