RX15-8

1. **Research Title:** High Resolution Electron Optical Characterization of Interfaces in Organic-Based Solar Cells
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 and Engineering, Chemical Engineering, Physics, Chemistry (MS or Ph.D. level)

4. **Objectives:** The technical objective is to provide materials charactaerization to enhance our understanding of the effect that engineered metallic interfaces have on the morphology and performance of organic bulk heterojunctions (org-BHJs). Film morphology and composition play an enormous role in determining the device efficiency of organic photovoltaics and functionality of other electro-optic devices. Films and devices will be fabricated, assembled and studied using advanced electron microscopy techniques and expertise such as Electron Energy Loss Spectroscopy, Energy Filtered Transmission Electron Microscopy (TEM), Electron Tomography, and Low Dose High Resolution TEM. A variety of interfaces will be explored, including ligated nanoparticle systems such as gold nanorods and nanospheres embedded within the org-BHJ matrix, and chemically/physical modified electrode surfaces.
5. **Description:** Organic photovoltaics have shown potential for replacing silicon based photovoltaics in select applications, because of their low cost and versatile processing. Significant materials challenges remain before the efficiencies of current devices are high enough to make organic photovoltaics a viable technology. One key challenge is that, because of the relatively high exciton binding energy in organic materials as compared to silicon, excitons do not dissociate freely, rather they must first diffuse to a donor-acceptor interface before being separated. Quantitative information pertaining to the size-scale of the donor and acceptor phases, and the morphology of the donor-acceptor interface, is therefore critical for understanding structure-properties relationships in organic photovoltaics. Additionally, because the carrier mobilities of organics are highly dependent on the local degree of structural ordering, and high mobilities are needed to move charges to their respective electrodes for current generation in a solar cell, it is critical to characterize local order at the molecular level within each of the donor and acceptor phases.

The incorporation of gold nanoparticles into BHJs has been shown to increase the power conversion efficiency of solar cells in select cases, although the mechanisms of this process are not well understood. This work will elucidate the fundamental mechanisms for this efficiency enhancement. Additionally, the electrode-active layer interface is critical for maintaining device performance and lifetime. This research will determine how changes in the chemistry and structure at this interface affect device function.

6. **Research Classification/Restrictions:** This research has no ITAR restrictions.
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-2013-3293