RX14-19

AFRL RESEARCH TOPIC CALL FOR FY14

1. **Research Title:** The role of graphene on polymer structure and charge transport in high-efficiency polymer blend solar cells

2. **Individual Sponsor:** Dr. Peter Mirau
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3. **Academic Area/Field and Education Level:** Materials Science & Engineering, Chemical Engineering, Chemistry, Physics, Mechanical Engineering (MS or Ph.D. level).

4. **Objectives:** To develop a fundamental understanding of the influence of pristine graphene incorporated in the active layer of all-polymer solar cells, and to employ this knowledge to design and fabricate organic photovoltaics (OPV) demonstrating a quantum leap in power-conversion efficiency. The research will investigate the mechanisms underlying enhanced short-circuit current and percolation in devices with graphene. All-polymer blends that utilize chromophore and graphene combinations to provide maximal coverage over the solar spectrum will be designed and tested.

5. **Description:** OPVs are of great interest to AFRL, but applications are limited by the poor performance of current photoconversion materials. The most important challenges confronting OPVs today are 1) extremely poor charge mobilities in polymers, and 2) diminished coverage over the solar spectrum. It has recently been shown that dispersing pristine graphene in the active layer of polymer solar cells leads to a three-fold increase in short-circuit current and power conversion efficiency. It is speculated, but not conclusively shown, that this increase is due to the enhanced mobility of electrons and holes. The goal of this project is to provide a molecular-level understanding of the mechanisms that lead to increased performance. For example, it is known that charge transport in graphene itself is dependent on environmental factors, but the effect of doping by adjacent π-conjugated polymers is unknown. The interaction between graphene platelets and polymers, including morphological and electronic changes induced by the graphene-polymer interfaces will be identified. In particular, the molecular and mesoscale structure, and charge and energy transport processes that occur in a ternary blend of semiconducting polymers with graphene will be studied. The mobility of charges and their dependence on graphene content will be measured. Various methods, including time-of-flight studies, field-effect transistors, current-voltage measurements, time-resolved spectroscopy, NMR, Grazing Incidence XRD and electron microscopy will be employed. The comprehensive knowledge of polymer-graphene interactions will be used to design polymer-blend solar cells that address the fundamental drawbacks of organic photovoltaics systems.

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

7. **Interest in Summer USAFA Cadet (Avg Cost for USAF Cadet for 33 days was $5000):**

   Not interested in sponsoring a cadet

   Eligible Research Institutions: Place an X in all that apply. PA# 88ABW-2013-3657

   X Universities (DAGSI) ☐ AFIT (only) ☐ USAFA