RX15-18

1. **Research Title:** Nanocarbon Synthesis and Application
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, Artificial Intelligence, Robotics, Electrical Engineering, Operations Research and Applied Mathematics (MS or Ph.D. level)

4. **Objectives:** The technical objectives of the topic are: 1) To understand and control the synthesis of nanostructured carbon materials such as carbon nanotubes and graphene, and 2) to use nanostructured carbons in applications including batteries, field emitters, sensors and electronic devices. We use "Automated Rapid Experimentation and in-situ Spectroscopy" (ARES) as a method for our investigations.
5. **Description:** Nanostructured carbons, including carbon nanotubes and graphene have shown exceptional promise in applications ranging from high strength/stiffness structural materials to chem-bio sensors, electronic devices, and electrodes for energy storage and field emission. Currently controlled synthesis is one of the major limits on our ability to transition these materials into fielded applications. We are developing ARES as a method to greatly increase our ability to explore experimental space for both synthesis and applications by developing automated (i.e., pre-planned, without user intervention) experimentation, and then autonomous (i.e., fully closed loop experimentation with only high-level user interaction). Our multi-disciplinary team comprises materials, physics, artificial intelligence, electrical engineering, and robotics. In the near future we plan to expand the disciplines to encompass Operations Research and Applied Mathematics.

http://www.nature.com/nmat/journal/v11/n3/abs/nmat3231.html
Rao et al., "In situ evidence for chirality-dependent growth rates of individual carbon nanotubes", Nature Materials, V. 11, pp. 213-216, 2012 doi:10.1038/nmat3231

http://pubs.acs.org/doi/full/10.1021/nn304064u
Rao et al., "Revealing the Impact of Catalyst Phase Transition on Carbon Nanotube Growth by in Situ Raman Spectroscopy." ACS Nano, 2013, 7 (2), pp 1100–1107
DOI: 10.1021/nn304064u

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