RX17-13

Nanoscale materials behavior in Radar Frequency (RF) devices

1. **Research Title:** Nanoscale materials behavior in Radar Frequency (RF) devices
2. **Individual Sponsor:**

Dr. Donald L. Dorsey, AFRL/RXAN
AFRL/RXAN Bldg 651
3005 Hobson Way
WPAFB, OH 45433-7707
Donald.Dorsey@us.af.mil

3. **Academic Area/Field and Education Level:**
Materials Science and Engineering; Electrical Engineering; Physics. (MS or Ph.D. level)
4. **Objectives:** Research and develop techniques to characterize the electrical behavior at the nanoscale of operating solid-state RF electronic devices. This includes the identification and distribution of electrically active defects and the distribution of charge as a function of device operating conditions. Apply these techniques to a pathfinder materials/RF-device system to discover and analyze how the electronic processes of device operation lead to long-term degradation in RF devices.
5. **Description:** Full exploitation of emerging solid-state RF electronic devices is increasingly limited by a lack of knowledge of the detailed materials behavior at the nanoscale. Technology trends are towards an increased use of less mature materials; increased scaling; higher frequency operation; and higher power densities. The consequences are reduced knowledge of the existence, properties and behavior of atomistic defects; a greater impact on performance from poorly understood materials interfaces; unfamiliar operating regimes and unprecedented operational stressors within the devices. Nanoscale analysis of materials in RF devices has been hampered by diffraction limitations (for optical techniques); access to the active regions of devices; and the availability of systems designed for in-situ characterization during device operation. Existing characterization techniques for electronic behavior of devices are incapable of localizing the defects sufficiently for direct use in detailed multi-physics device models. These models will not be fully deterministic until this challenge is resolved. Some potential characterization approaches include scanning electron microscopy (SEM) and scanning probe microscopy (SPM). Key challenges include sample preparation approaches that enables device operation, in a representative manner, during in-situ characterization; characterization equipment modification to enable in-situ biasing of electronic devices; and the decoupling of the physics of device operation from the effects of the ambient atmosphere.
6. **Research Classification/Restrictions:** This research has no ITAR restrictions.
7. **Eligible Research Institutions:** Indicate to what organizations this topic should be provided

[X] **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.