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1. **Research Title:** Thin Film Research for Optical Coatings & Metamaterials

2. **Individual Sponsor:**
Dr. Rachel Jakubiak, AFRL/RXAP
AFRL/RXAP
3005 Hobson Way
WPAFB, OH 45433
Rachel.jakubiak@wpafb.af.mil

3. **Academic Areas/Field and Education Level:** Materials Science & Engineering or Physics or Electro-Optics/Thin Film Coating Design, Vacuum Deposition, and Characterization (MS or PhD Level)

4. **Objectives:** This research task involves finding material systems that allow spectral filtering of electromagnetic (EM) radiation across the visible, near infrared and infrared (VIS/NIR/IR) spectral regions. Techniques required in this effort include thin film deposition, metamaterials, EM design, characterization of optical properties and material composition. The overall goal of the research is to promote the use of non-conventional thin films in optical applications through an understanding of structure/property relationships of novel material systems.

5. **Description:** This project explores innovative concepts for material systems to be used in applications that use optical coatings such as notch filters, anti-reflection coatings and induced transmission filters (aka - transparent metals). These coatings play an important role in increasing the sensitivity of sensors and detectors as well as enhancing the performance of a variety of optical components. Possible materials used in these coatings span the gamut from organic polymers to metallic films. In designing a coating for a specific application the optical dispersion (variation of the complex index of refraction with wavelength) of each material is taken into account and a model prescribing the thickness and distribution of each layer is determined. The vast majority of optical dispersions used in optical design software are for bulk materials that rarely exhibit the same dispersion when in very thin films. This leads to a disparity between the model and experimental results. To overcome this problem, detailed studies of the optical and physical properties of a variety of materials, including engineered structured materials (metamaterials) and ultra-thin (<10nm) films derived from dielectric, semiconductor and metallic materials, will be undertaken. Since the complex refractive index varies significantly with the degree of long range order and void fraction within the films correlating the deposition conditions with the resulting optical properties will be most valuable for reproducibility.

6. **Potential Commercial Impact and Industry Involvement:**
Optical thin film coatings find broad application in the aerospace and defense industry including dichroic and bandpass filters for sensors, anti-reflection coatings for instrumentation displays, IR filters for thermal imaging and conductive coatings for electromagnetic interference suppression, just to name a few. Any research product derived from this proposed work would be transitioned to one of our industrial partners: JDSU, Teledyne or Deposition Sciences, Inc.

7. **Research Classification/Restrictions:** This research is FOUO and has ITAR restrictions.
8. **Interest in Summer USAFA Cadet (Avg Cost for USAF Cadet for 33 days was $5000):** Not at this time.
9. **Eligible Research Institutions:**

■ Universities (DAGSI) ☐ AFIT (only) ☐ USAF