

1. **Research Title:** *Non-destructive Evaluation of Urethane-Epoxy Coating Systems*

2. **Individual Sponsor:** Dr. Walter Juzukonis, AFRL/RXSC

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3. **Academic Area/Field and Education Level:** MS level in Materials Engineering

4. **Objectives:** Development of a nondestructive evaluation (NDE) technique for measuring and analyzing the degradation and reversion of urethane-epoxy coating systems using a scanning Kelvin probe (SKP) technique to address the need for NDE tool for aircraft outer mold line (OML) urethane and epoxy integrity assessment and to identify premature failures.

**Description:** The SKP is a non-destructive inspection technique that has been used to investigate the electrochemical properties of surfaces, coatings and polymers over the last 20 years. The SKP technique has been used to measure the difference in the work function of polymers adsorbed to solid substrates by using a backing potential to null the current between the sample substrate and a vibrating probe that is electrically connected to the substrate and positioned close to the sample surface. This difference in work function between the non-contact scanning Kelvin probe and the underlying substrate is defined as the contact potential difference. The utility of the SKP technique in the laboratory to characterize changes in molecular conformation in adsorbed organic layers at the air/solution interface and on solid substrates has been demonstrated and changes in the alkyl chain lengths of polymers and their terminal groups have also been determined using the SKP technique. The specific questions that will be addressed during the first year of this effort are:

1. Is it possible to differentiate between a polyurethane rain erosion coating and an epoxy primer coating system using the scanning Kelvin probe technique?
2. Is it possible to differentiate between a degraded and non-degraded polyurethane coating, epoxy primer and polyurethane/epoxy primer stack up coating system using the scanning Kelvin probe technique?

Success in meeting the objectives of the first year of the program will demonstrate the ability of the scanning Kelvin probe to quantitatively measure the degree of degradation of both a polyurethane coating, an epoxy primer and a stack up consisting of the two coatings. The objectives for a second year would focus towards developing a field-rugged prototype SKP system:

1. Design a portable scanning Kelvin probe system that could be used in the field on aircraft OML coatings?
2. Test the prototype system on a stack of four representative outer mold line coating materials.

The design requirements for the probe will be to be able to identify degraded areas in both horizontal and vertical axes of the coating system stack up on OML coatings over an area of at least 1 m<sup>2</sup> in a single measurement scan. Additional work could include alignment with, and development of, a tool for prediction of degradation/reversion or OML coating systems on aircraft.

**5. Research Classification/Restrictions:** *Inform researchers about potential classification levels and restriction associated with the research.*

**6. 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)

**PA Approval #: 88ABW-2013-3741**

AFIT (only)

USAFA (only)

If you are submitting a topic for the USAFA, please indicate if you are also interested in sponsoring a USAF Cadet in summer of 2013 (**Avg Cost for USAF Cadet for 33 days was \$5000**)

Yes      No

No