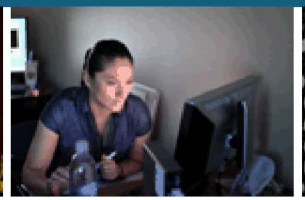
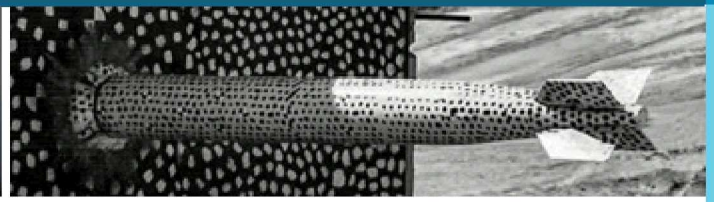
SAND2019-11593R

LDRD Ending Project Review
Polymer-Spray Coating Interfaces (Project 215984)





PI: Andrew Vackel, org. 1834
PM: Joe Fonseca, org. 1834
Team Members: LaRico Treadwell (org.1815), Erica Redline (org.1853), Samantha Siska (org.1834)

FY19, $100K Total Cost

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PURPOSE, GOALS AND APPROACH

What is the ST&E question that inspired you to do this research?

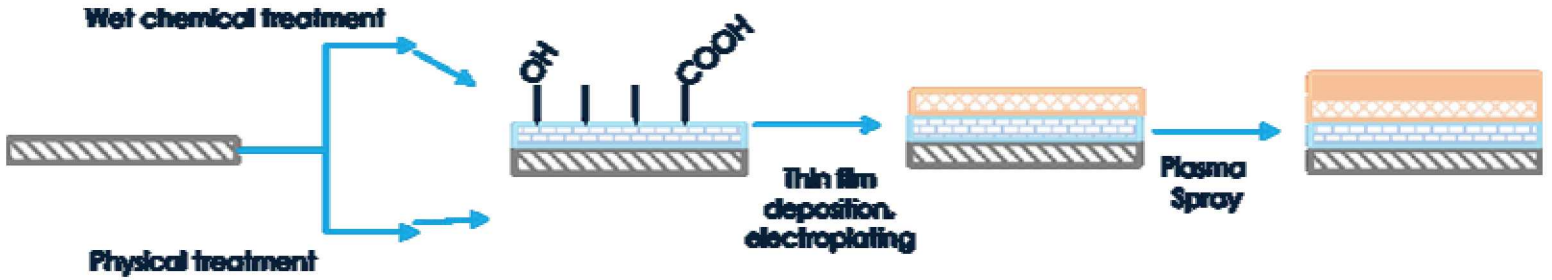
The ability to surface engineer structures or components using coatings made by the thermal spray processes is very common practice and offers great design flexibility with traditional structure metallic substrates (e.g., Al, Steel, Ti). However, the joining of high melting temperature materials to a polymeric substrate presents a problem due to the melt deposition coating formation mechanism locally subjecting the polymer substrate to temperatures exceeding the limits of the polymer. Thus, it was desired to modify the surface of a polymer so that a thin metallic film could be robustly bonded to the polymer and act as a heat sink for impinging molten droplets from a thermal spray process and allow a thick film coating to be built upon the polymer.

PURPOSE, GOALS AND APPROACH

How was this different from previous research?

Previous research involving thermal spray deposition would rely on spray application of a low melting material (e.g., Zn) onto a polymer surface followed by subsequent material layers. This approaches limits materials that can be used and relies only on a mechanical bond between the metal and polymer

We propose an approach where creating a chemical bond between a thin metallic film and the polymer would enable plasma spray deposition of thick film materials

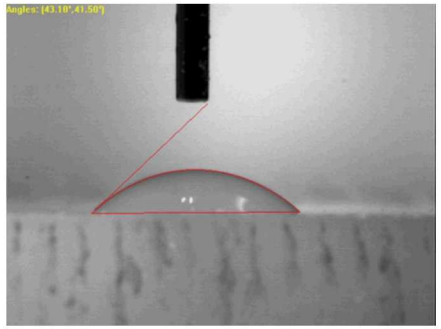


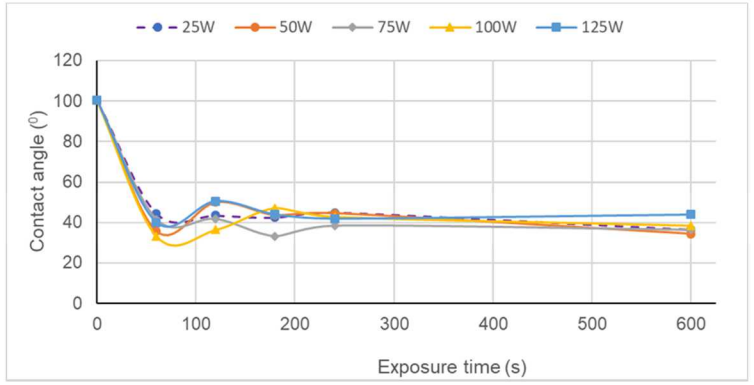
PI's PROJECT LEGACY

[Summarize this research from your personal and professional perspectives. Use 1–2 slides]

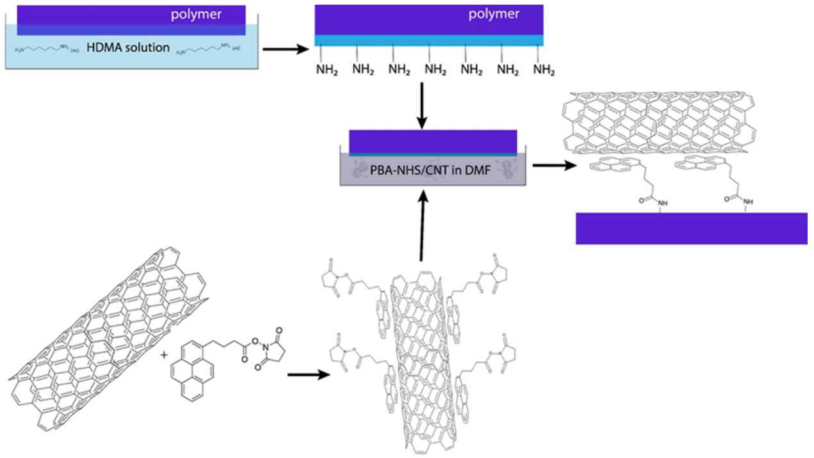
List notable, key results in terms of importance to ST&E and capability development at Sandia.

- *Characterization and robust demonstration of plasma etching and chemical-based surface preparation*





- *Attachment of carbon nanotubes to polymer surface through chemical process*



PI's PROJECT LEGACY

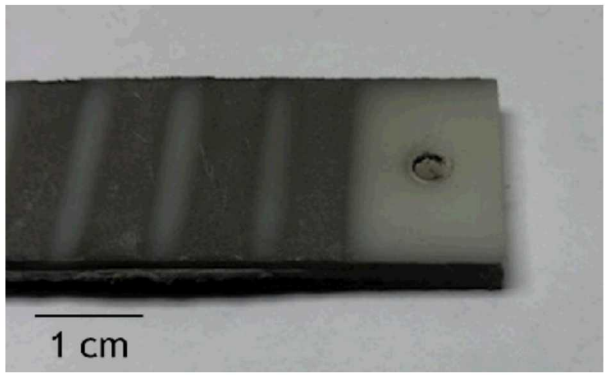
[Summarize this research from your personal and professional perspectives. Use 1–2 slides]

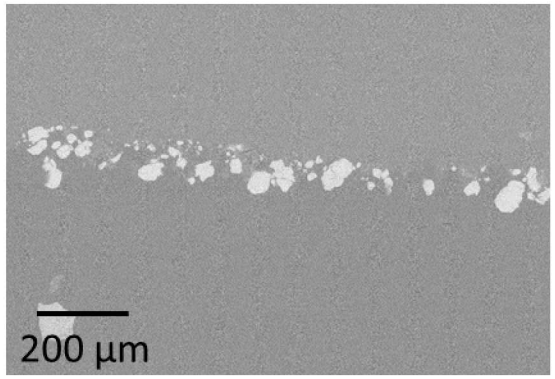
What will be the impact of your project results, both in your field and in potential applications?

- *Project identified and laid ground work for a pathway to make thick metallic coatings onto a polymer substrate with chemical bonding*

What are the key aspects of this research you would want your colleagues to take away? What are you most proud of? Did anything not work as expected? Include all of the following:

- *A promising capability for thermal spraying high melting temperature materials onto polymeric substrates with a chemically bonded interlayer has been developed, whereas previous work relied on direct spray application with limited materials and mechanical bonding*
- *Cold Spray may not work as a direct coating application, though this process could be used for the final thick metallic layers as an alternative to plasma spray*





PROJECT OUTPUTS

- Technical Advance SD# 15163 "Method for chemically attaching carbon nanotubes to polymer" by Erica Redline
- Undergraduate student poster presentation at Rio Grande Symposium 2019 "Metallization of Polyethylene via Cold Spray" by Samantha Siska, Andrew Vackel, Jacob Mahaffey, Joe Padilla

CAPABILITIES DEVELOPMENT

- Establishment of Capabilities expected to impact future work
  - Better characterization of the cold spray process and its limitations in directly coating polymeric substrates
  - Proven robustness of the plasma etching process for surface activation of polymers for plating process
  - Novel method for chemically treating surfaces by attached carbon nano tubes to polymers
- Career Development
  - Team and PI consisted of early career staff members with consultation from experienced staff members
  - Project involved work from student intern (Samantha Siska)

TEAM BUILDING AND PARTNERSHIPS

- New research teams or collaborations formed – internal or external
  - Joint process development between polymer and spray coatings SMEs
  - Informed by needs of orgs within center 1300

IA/PM PROJECT LEGACY

[not to be completed solely by PI— use 1-2 slides]

How did this project contribute to IA strategic goals and objectives?

- These material synthesis methods explored pathway toward novel material stack ups

- Metrics met through this IA
  - Early Career staff development
  - Partnership across several 1800 orgs
  - Applied opportunity for student intern
  - Technical Advance as result of work
- Lessons learned, good or bad
  - Surface treatment methods offer robust way for activating polymer surfaces
  - Limitations exist for Cold Spray coating application

What are the key results from this research that will be useful to other current and future projects?

- Characterization of Cold Spray thermal factors
- Characterization of surface activation techniques
- Pathway for building intermediate layer to allow plasma spraying of polymers provided

Technology insertion and follow-on funding for potential and realized ROI

- Continued low level effort through RDC&S
- Used as method for fabricating samples for future LDRDs pertaining to metal-polymer interfaces