Evaluation of Clear Topcoats to Alter Chemical Resistivity of Polyurethane Coated Military Assets

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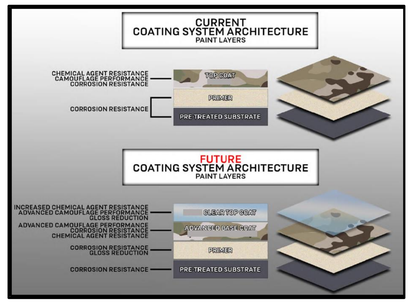
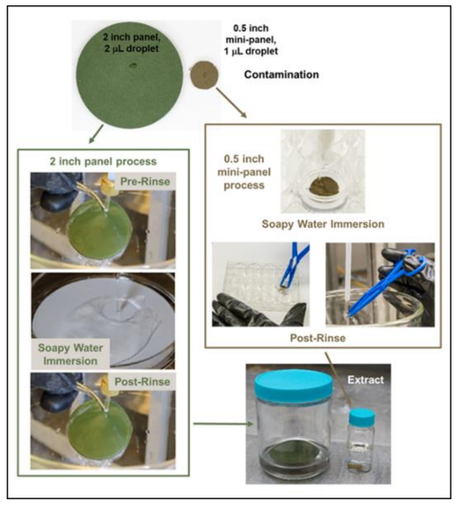
Background:

A rugged, protective clear topcoat is a technology that will enhance chemical decontamination capability by enabling more facile decontamination of assets contaminated by chemical warfare agents (CWAs). The temporary protective overcoats will provide easier decontamination ability compared to unprotected polyurethanes (PU). This will reduce contamination which will enable the reduction of personal protective equipment (PPE) requirements. The protective temporary overcoats will reduce the amount of retained agent while maintaining initial chemical resistance and other physical properties for a minimum of 6 months.



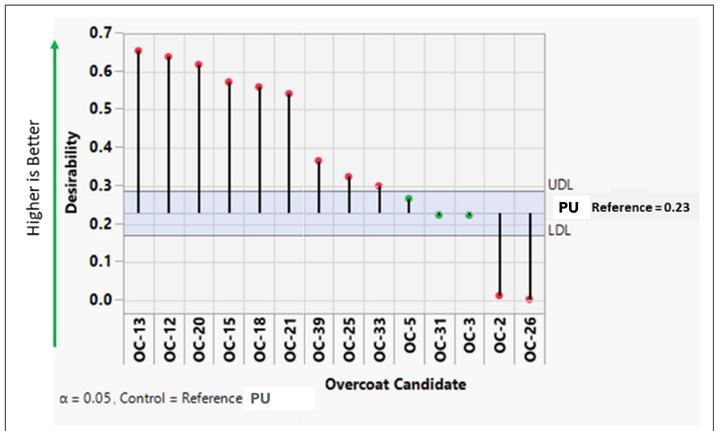
Phase One Materials, Chemicals, Methods

- Low gloss PU paint, three pigment types (Green, Black, and Tan), sprayed on metal substrates were used for application of overcoats and as reference coatings
- Overcoats provided by various vendors from academia, industry, as well as commercial off the shelf products (COTS)
- Chemical warfare agents: GD, HD, VX
- Phase One: Modified CARM procedure for analyzing retained agent utilizes 0.5 inch mini-panels to facilitate large scale screening of multiple technologies with less waste and higher through-put.

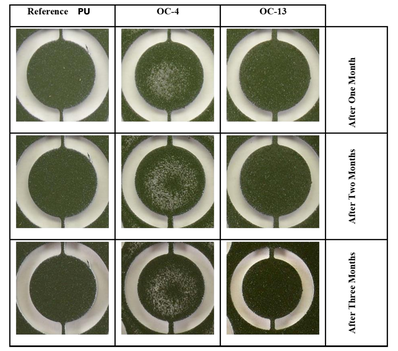


Phase One Results/Analysis

- Overcoat candidates (OC) were compared to reference coating performance.
- Reference coatings were carried throughout each day to account for day to day variability.
- The Dunnett's method for making multiple statistical comparisons against a control was used to determine if each OC's cumulative (across all 9 Agent-Color combinations) performance was statistically different from the Reference PU sample.
- The Desirability function offers more sensitivity to an Overcoat that might have poor performance at a particular Agent-Color combination than would be obtained if one simply used the mean of retained agent (RA) across the 9 Agent-Color combinations as a measure of Overcoat cumulative performance.
- OC-13, OC-12, OC-20, OC-15, and OC-18 are statistically similar in desirability based on cumulative RA performance over all combinations.
- Samples returned from 6-month outdoor weather (Homestead, FL) and were evaluated for defects and suitability of further testing.
- A down-selection was conducted from a combination of pre-weathering results and post-weathering suitability of materials for testing.

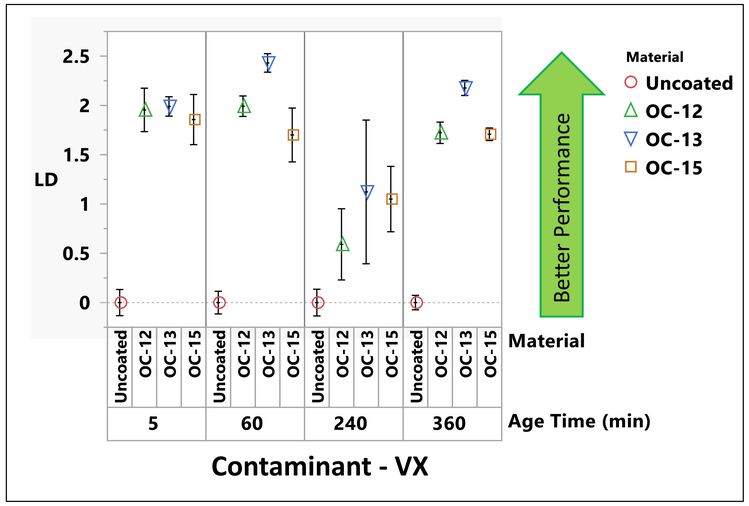


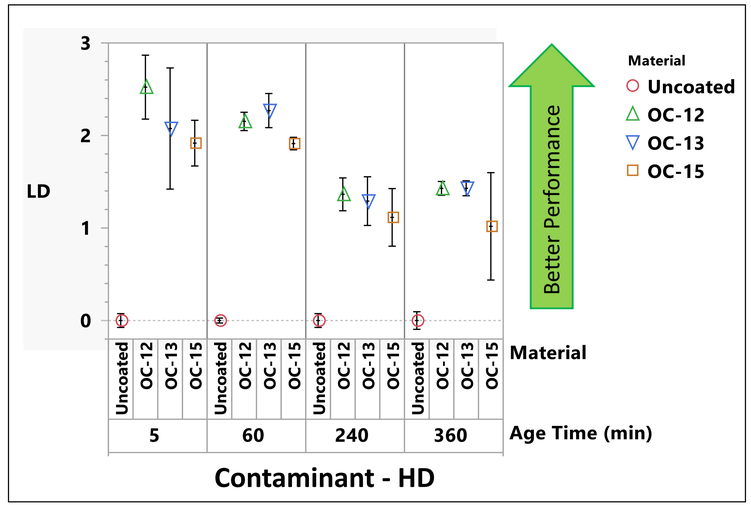
Dunnett's plot comparing desirability (cumulative performance over all Agent-Colors) for each Overcoat against the Reference PU coating. Green dots within the UDL-LDL band are statistically similar, Red dots outside of the UDL-LDL band are statistically different at alpha= 0.05.



Phase Two

- Down-selected to three overcoat candidates (OC-12, OC-13, and OC-15) for further agent resistance and weathering evaluations.
- CARM methodology applied for evaluation of agent resistance.
- Pristine OC samples were evaluated for initial agent resistance compared to uncoated samples.
- Log Difference (LD) method used to calculate an overcoat's performance relative to the reference uncoated material (Red circles) for each contaminant.
  - If LD is greater than 0, the overcoat candidate is LD orders of magnitude more effective than the uncoated reference. If LD is less than 0, the overcoat candidate is LD orders of magnitude less effective than the uncoated reference. The LD is calculated as the difference of the arithmetic mean of the $\log_{10}$ transform of the reference and test conditions.
- All coatings increased agent resistance compared to the uncoated material.
- Prolonged outdoor weathering will be conducted in humid and arid conditions with periodic sampling to assess any coating failures along the weathering timeline.
- Coatings will be evaluated for agent resistance using CARM after the completion of outdoor weathering.





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