



Assessment of Surface and Ground hAZards by Real-time Detection (ASGARD): Deposition Methodology Development and Characterization

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PROBLEM

Current drop-and-drop deposition systems today are unable to consistently and reliably reproduce precise, validated test samples, a capability that is critical for properly and correctly evaluating the performance of sensors and detectors. The lack of standardized, authoritative test samples for/ during / throughout the evaluation of these technologies increases the risk of **inaccurately assessing their performance**, which in turn can significantly hinder the proper understanding and delivery speed of these capabilities.

OBJECTIVE

Two material deposition systems, the DCS 1800Z Printer and Nanoplotter, were acquired to support the efforts of both DTRA and JPM CBRN Sensors in the development of novel methodologies and technologies towards **establishing standardization and ensuring accuracy in the evaluation of sensors and detectors for surface and ground threats**.

This capability – which has applications in both the lab and operational / field environment – enables the community to **better understand surface contamination threat presentation** and more **accurately assess candidate technologies** for more robust detection of both bulk and low-level threat materials across the chemical hazard environment.

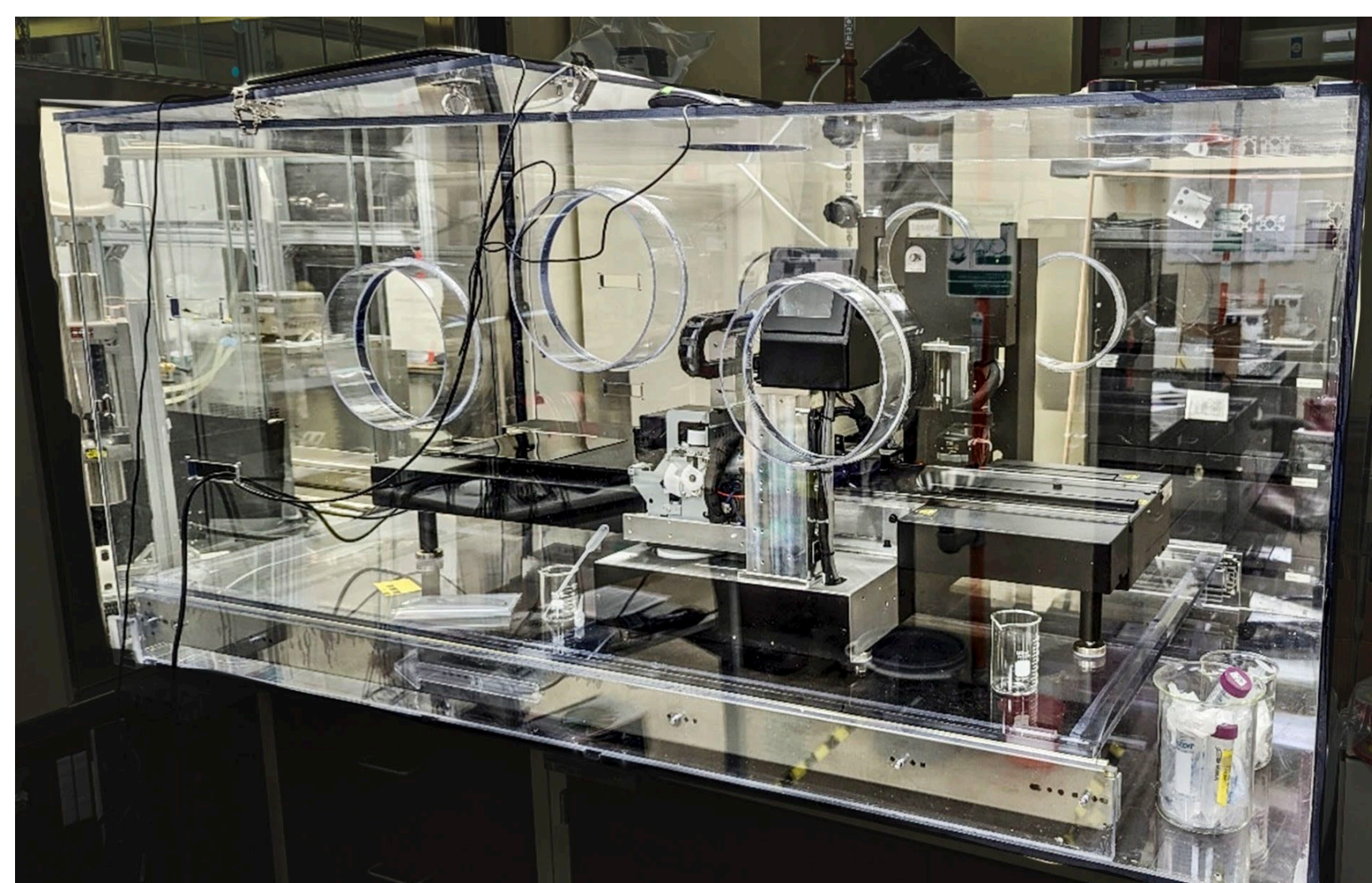


Fig. 1: The DCS 1800Z Printer housed in a chamber custom designed for operational safety.

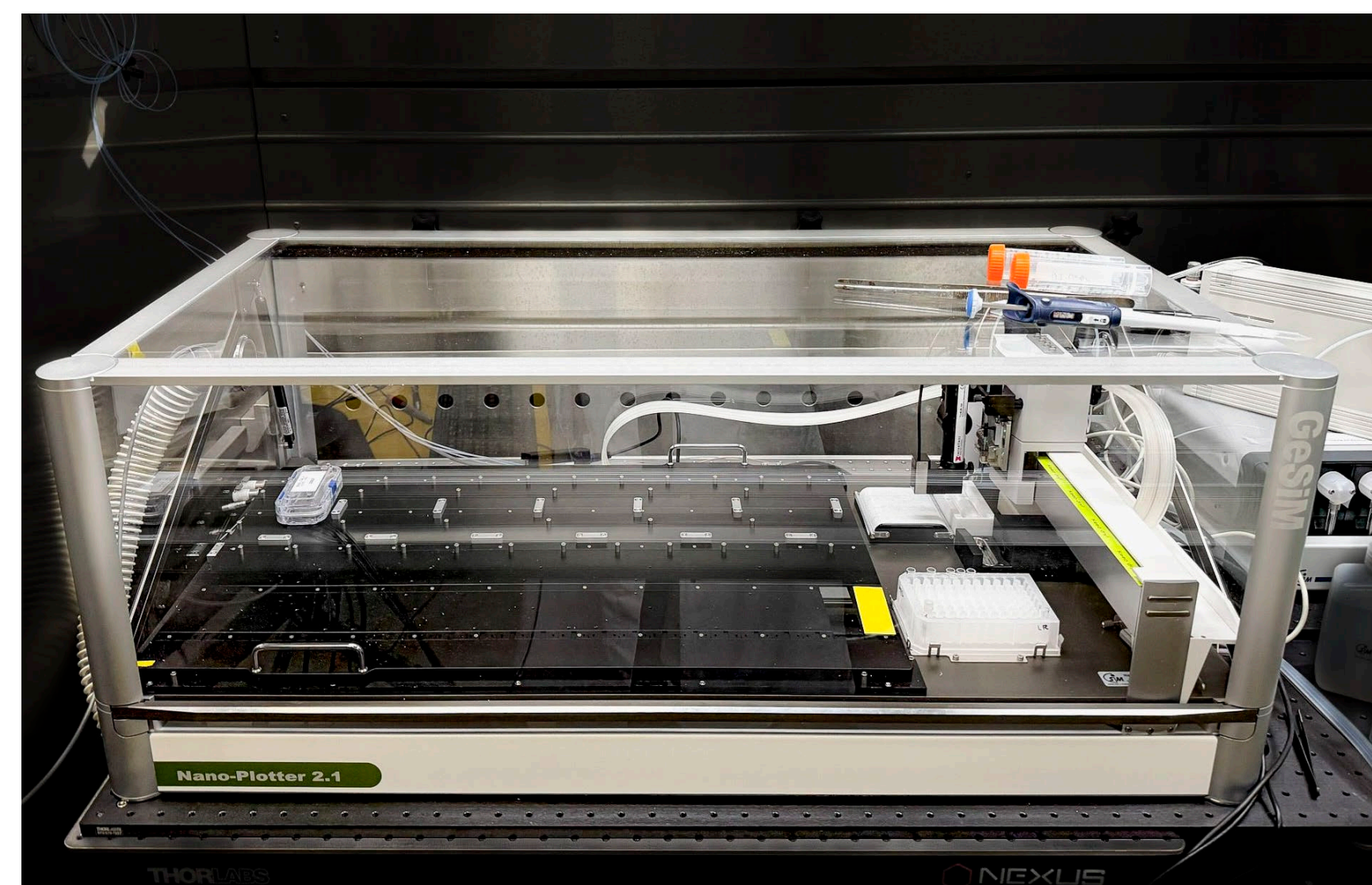


Fig. 2: The Nanoplotter inside the operating safety hood.

PRESENT USE

- To produce low mass loading coupons to complement the bulk amounts used for effective canine scent detection training under the **Working Dog Advance Threat Assessment System (WD ADTAS)**.
- To support the NATO SET316 RTG with creating coupons using inkjet printing that are both visually realistic and sensor agnostic that can be utilized in various scenarios such as checkpoints, temporary roadblocks and sensitive site exploitation.



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PRELIMINARY CHARACTERIZATION - DCS 1800Z Inkjet Printer

Chemicals

- Triethyl phosphate (TEPO)
- Rhodamine

Substrates

- Stainless Steel
- Aluminum-Coated Slides
- Leaf

Analysis Methods

- Gas Chromatography-Mass Spectroscopy (GCMS)
- Fluorometry
- Desorption Electrospray Ionization (DESI)



Fig. 3: Deposition of a rhodamine solution in a smiley face pattern on a leaf, visualized via DESI analysis scan.

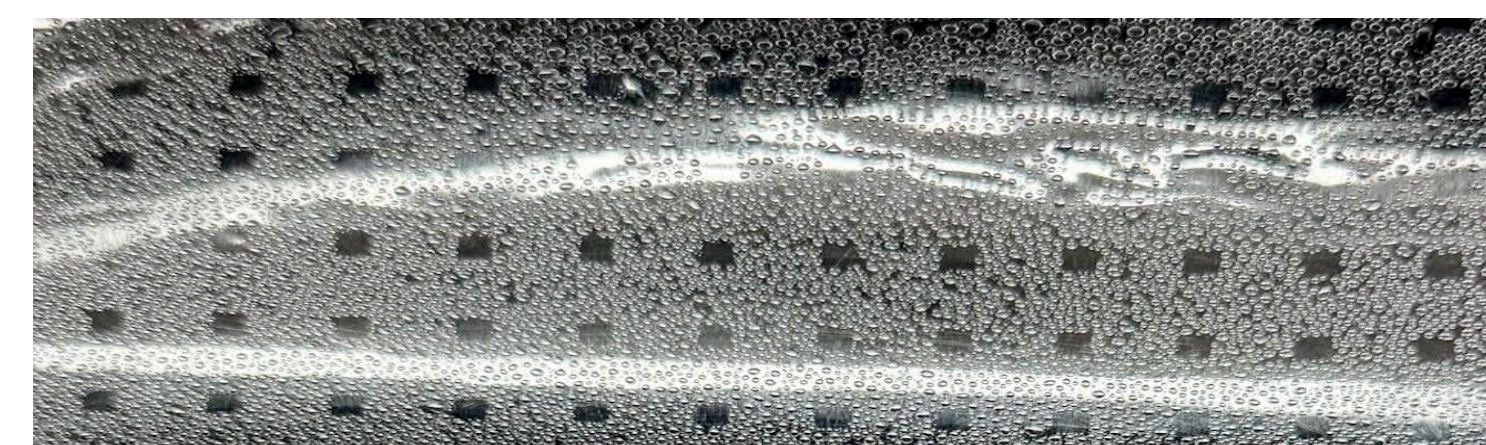


Fig. 4 : Deposition of a TEPO solution in a checkerboard pattern onto stainless steel surface.

COMPARING TWO DIFFERENT EXTRACTION METHODS

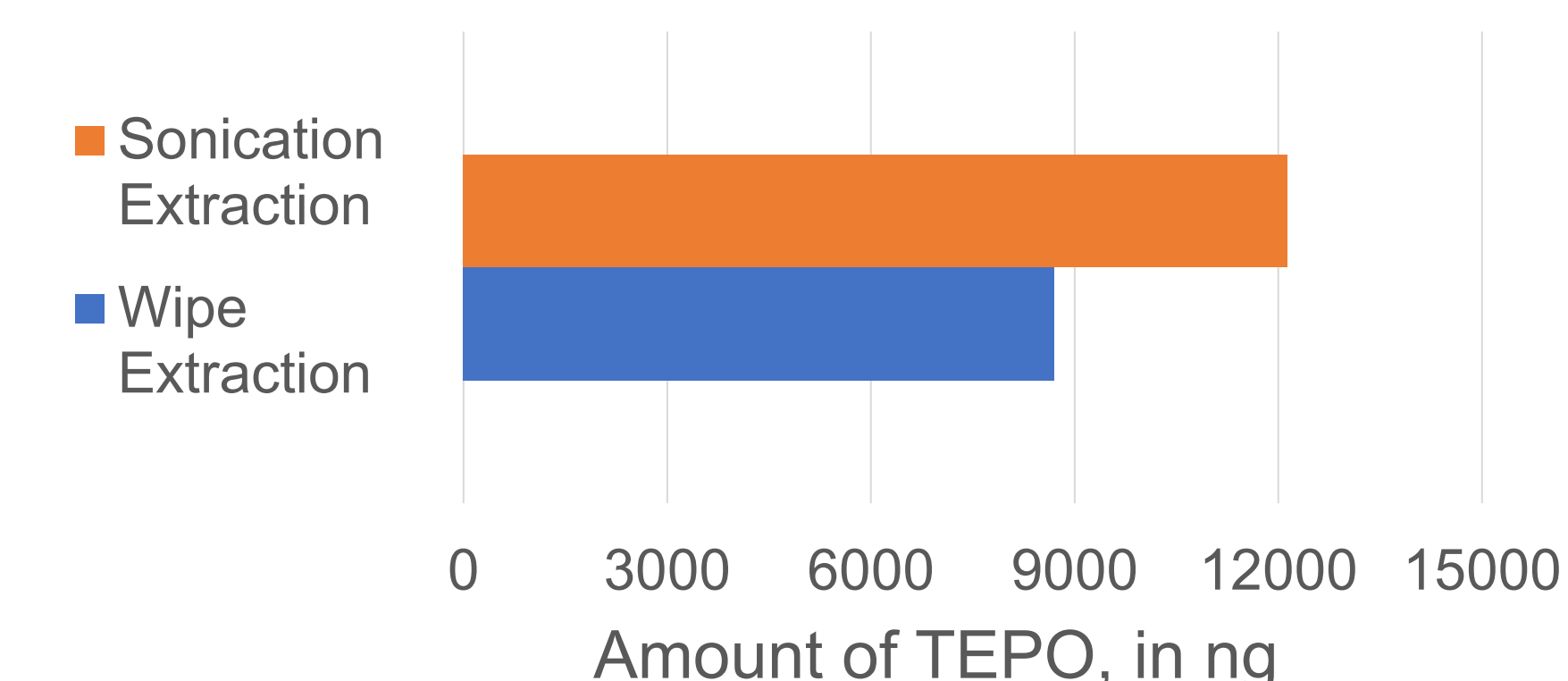


Fig. 5: Comparing the efficiencies of two prior established extraction methods, sonication extraction vs wipe extraction. For both methods, stainless steel was the substrate, dichloromethane was used as the extraction solvent, GC/MS was used for analysis. The sonication method was found to be the most optimal in this case, based on the amount of TEPO extracted and analyzed.

PRELIMINARY CHARACTERIZATION - GeSiM Nanoplotter 2.1

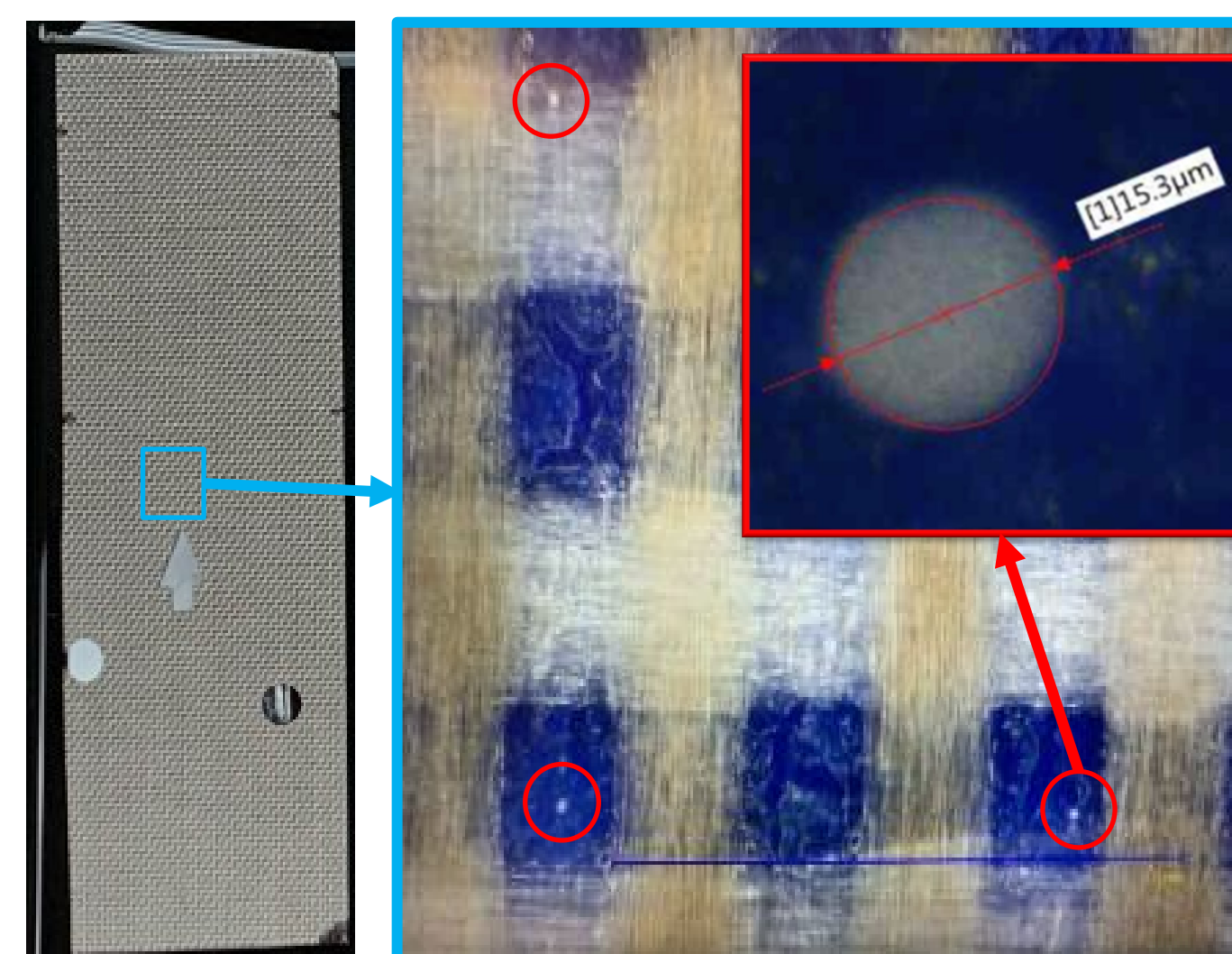


Fig. 6: Potassium chlorate particles on swabbing media

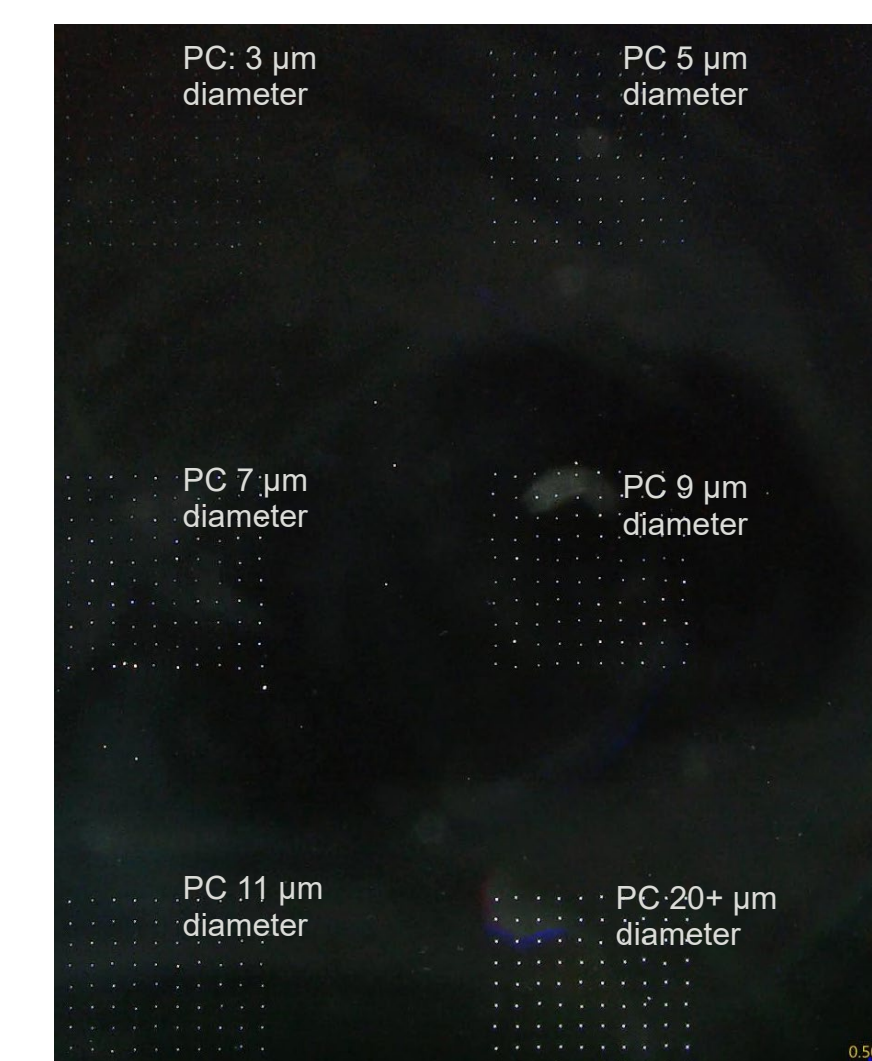


Fig. 7: Potassium chlorate (PC) particles on aluminum

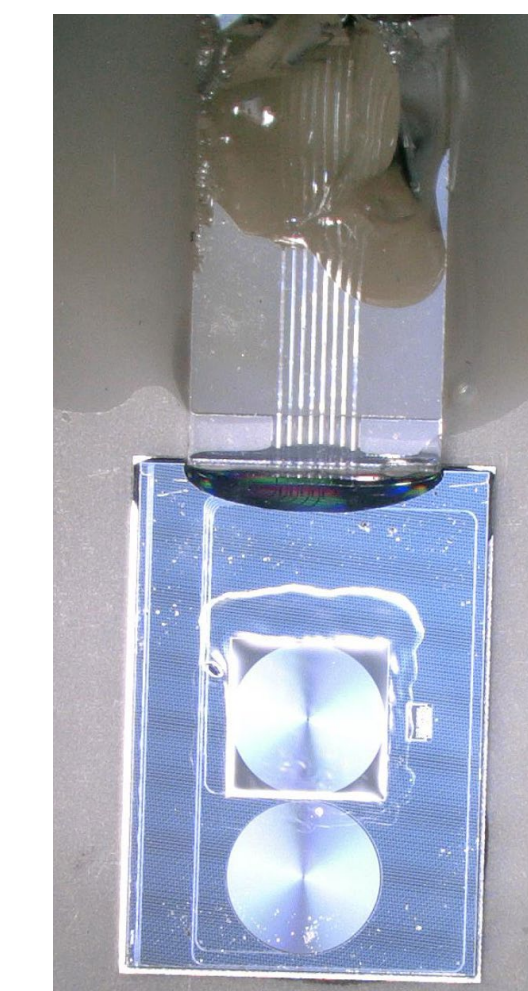


Fig. 8: Thin film polymer applied to IC microchip.

Applications related to sensor and detector technologies

GeSiM Nanoplotter is used to assist in alignment protocols and limits of detection studies.

Calibration standards have particle diameters between 3 μm to 50 μm .

Thin film polymer coatings can be generated with complex geometries, which can be precisely located onto specific waveguide areas of integrated circuit (IC) micro chips.

PATH FORWARD / NEXT STEPS

Continue with *full comprehensive baseline characterization* of the systems using relevant chemical materials; enable precise control of droplet volume, droplet size and number of droplets-per-inch

Parameters for consideration: Compatibility of the material to be printed, minimizing material consumption, chemical integrity, pattern efficiencies, surface coverage and areal density.

Planned methods of analysis: Raman Chemical imaging (RCI), High Performance Liquid Chromatography-Mass Spectroscopy (HPLC-MS) extraction, and GCMS.

By leveraging the takeaways and lessons learned during the preliminary characterization process, protocols will be developed and refined to enable precise particle deposition of hazardous chemicals, while also mitigating operator risk and optimizing the ease of system use.

OUTCOME

Decrease uncertainty and increase predictability in repeatable evaluation protocols through validated and standardized test samples, reproduced with high fidelity and in a reliable manner, strengthening the accurate assessment and proper understanding of sensor and detector performance in both lab and field-operational environments.

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