

Adhesion of powders to surfaces – and the implications for removal

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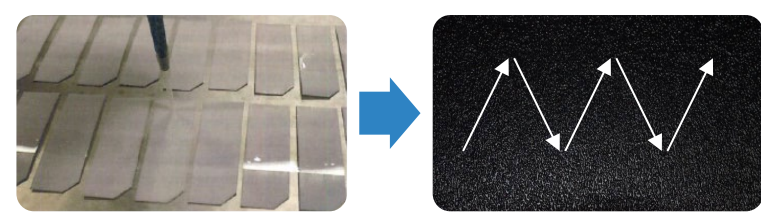
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Background



Defining the challenge:

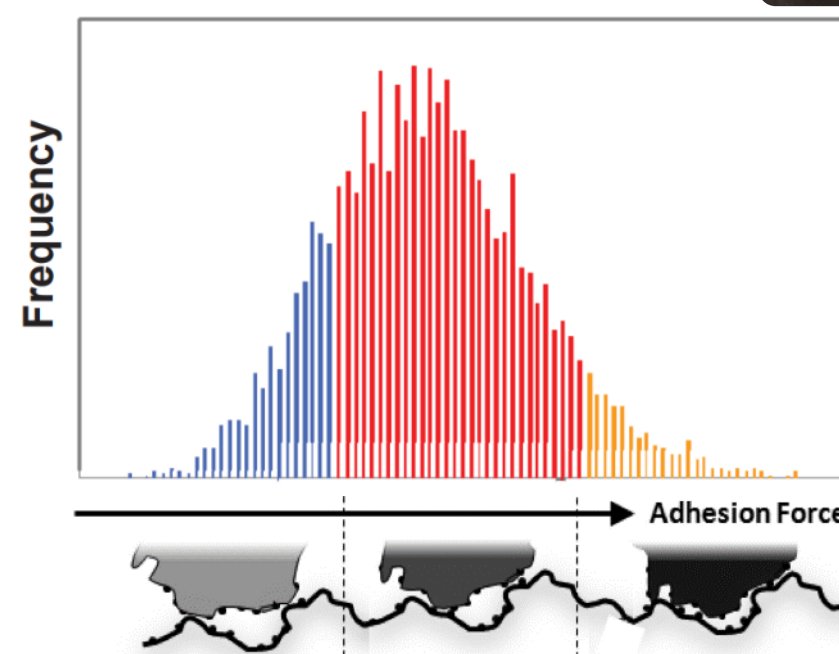
What is the operational scenario?
What happens during a contamination event?
How do we operate in the lab?
Does it translate to the field?



Overarching themes:

Humans are beautifully inconsistent
Identify the underlying problem
Be careful simplifying the problem
What questions should we be asking?

Distribution of Forces



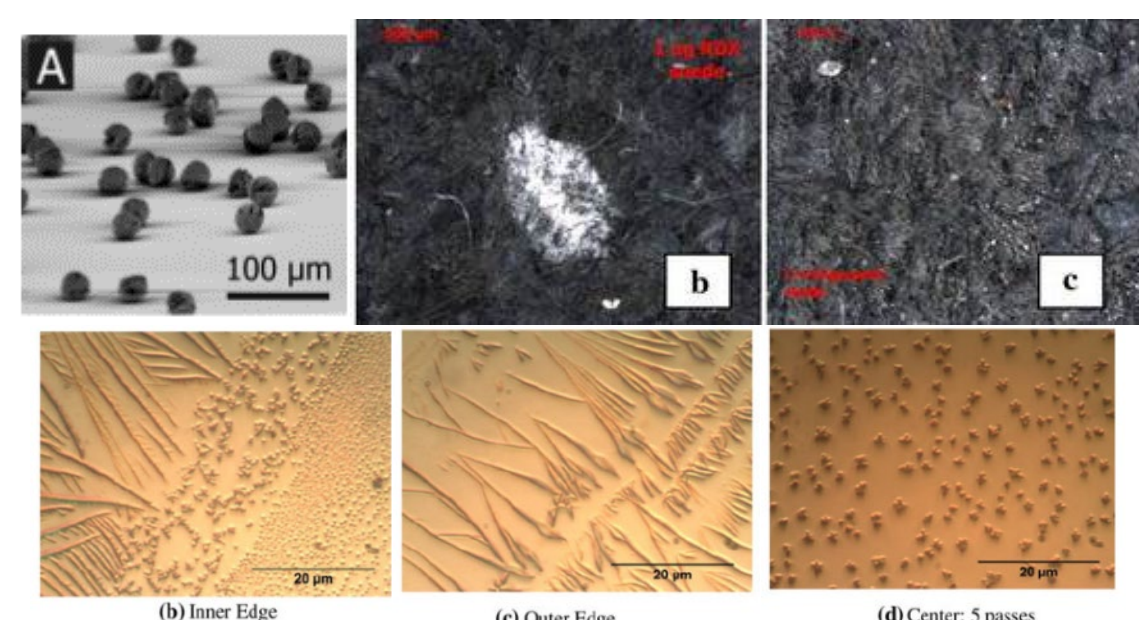
Theoretical adhesion:

Excellent lab based techniques
AFM, centrifuge, contact transfer
Single particle to powder population
Many attempts to scale from lab to
operational environment
Many challenges – particle
morphology, sample test bed,
automated or human sampling,
deposition and removal
techniques, etc., etc.

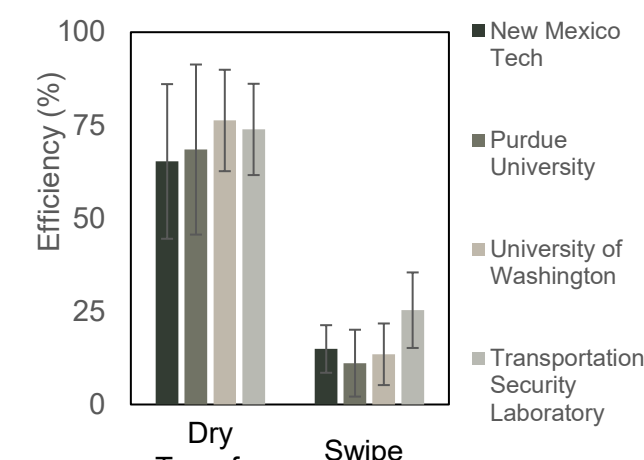
How do we ensure testing in the lab is operationally relevant?

Sample preparation techniques

- Deposition technique has a clear impact on particle formation.
- Inkjet: almost perfect spheres.
- Dry transfer: smudged, enmeshed
- Thermal inkjet: highly inconsistent coffee ring effect – combination of sizes (tiny to small) and shapes (spherical to acicular / dendritic).
- Note: different solvents will create different crystallinities.
- Fingerprint: spheroidal, nonspherical. Sitting atop surface, as opposed to tangled in fibers.
- Nothing quite replicates the behavior of a fingerprint... except a fingerprint.*



a: Piezo-electric inkjet (DMF)
b: Dry transfer (MeOH)
c: Fingerprinted (n/a)
d-f: Thermal inkjet (solvent mix)

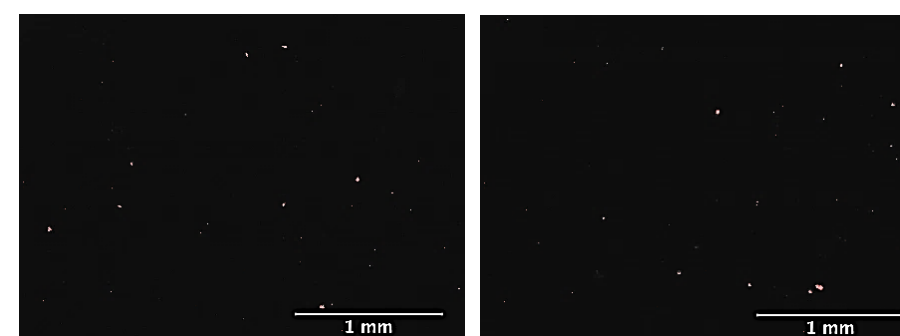


- Dry transfer: dissolved aliquot of contaminant deposited on nonstick transfer material, dried, smeared on target substrate
- Swipe: collection media drawn across target substrate to remove as much contamination as possible
- Highly controlled and consistent sample techniques used by four performers.
- Still see wide range of transfer inconsistency in deposition
- Less variability in swipe collection, but overall efficiency is low
- Obtaining consistent results is hard!

Following contamination (after final print)

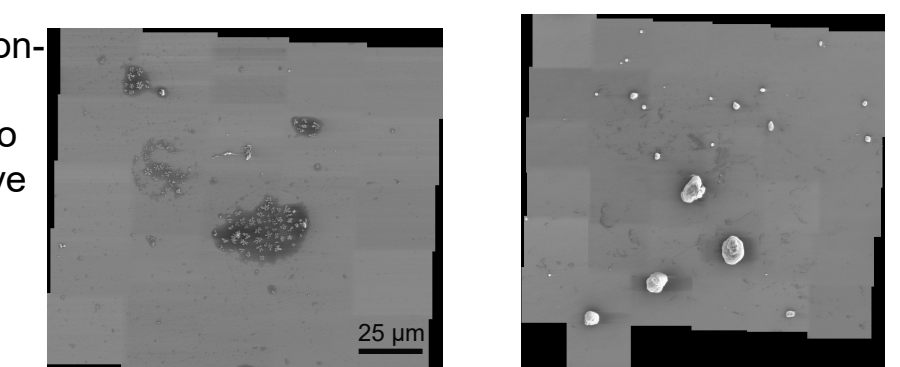


Ungloved Latex Nitrile

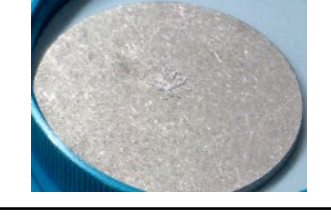
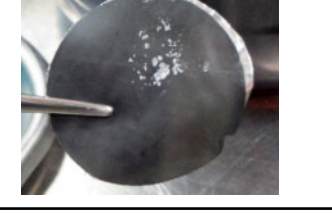


Clean thumbprint Contaminated print

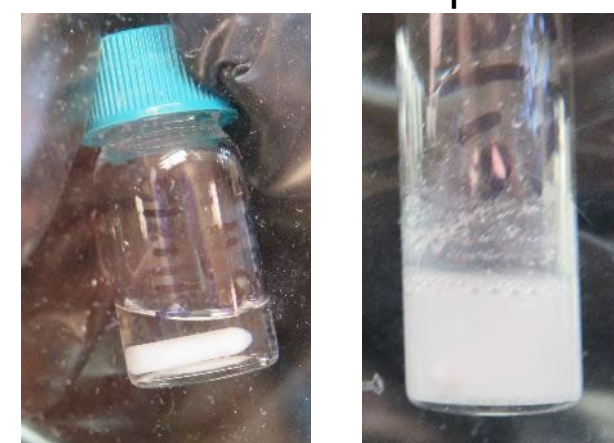
- Impossible to differentiate between contaminated and non-contaminated fingerprint via optical microscopy
- SEM images differentiate, but require substantial effort to isolate organic contaminant particles from inorganic glove and finger residues
- Aliquot deposition resulted in a surface plague with no visible particles present (optical or SEM)
- Bimodal distribution of very large and very small particle residues



Deposition Techniques

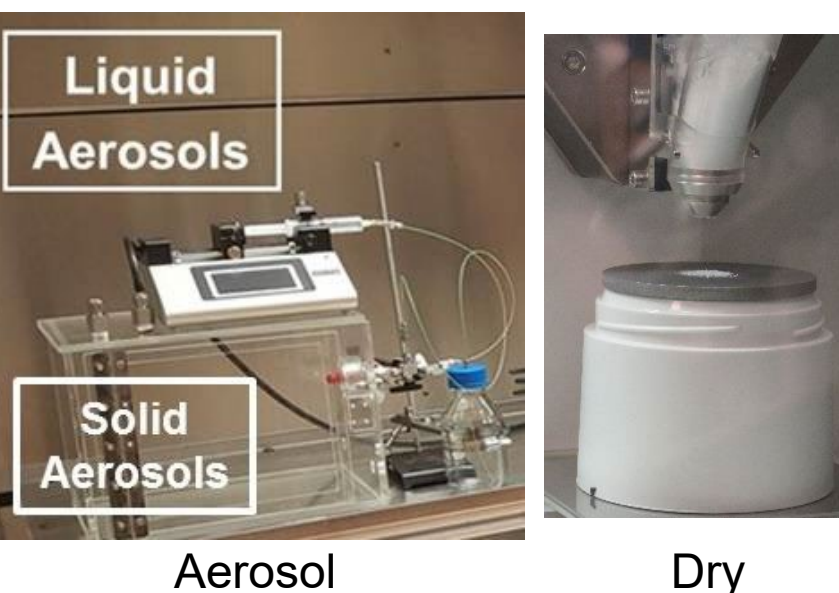
	Before contact (panel)	After contact (PPE)	After contact (panel)
Methanol solution			
Water suspension			
Aerosol deposit			
Dry dispersion			

Solution Suspension



Solution Suspension

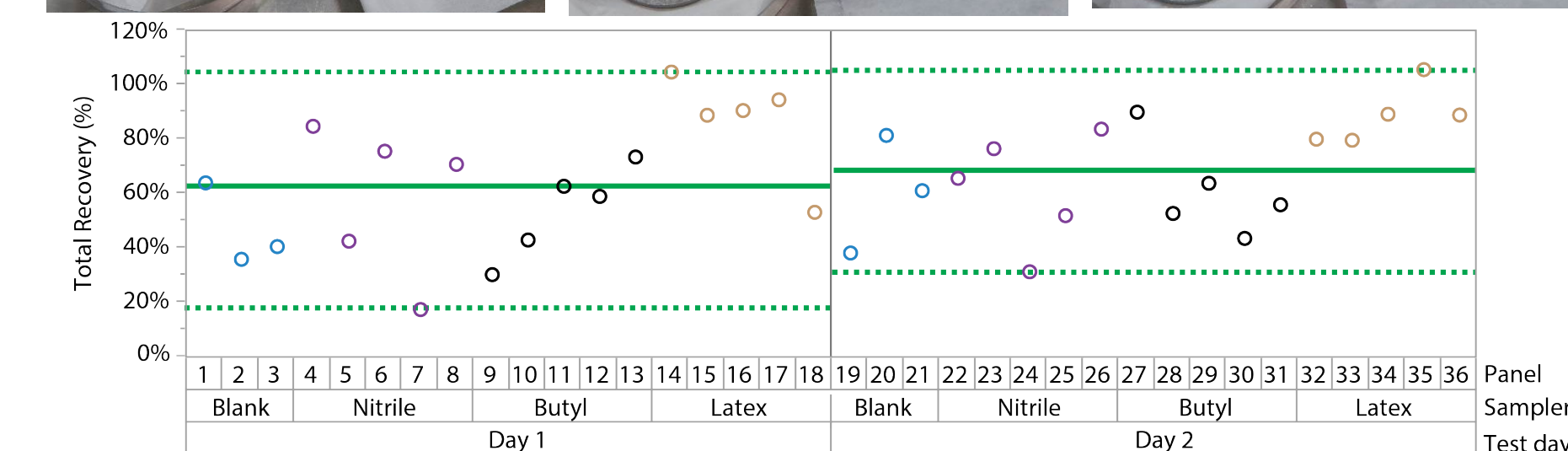
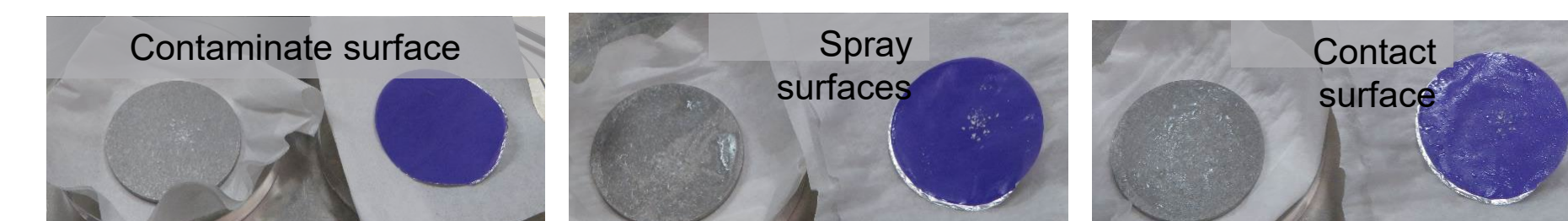
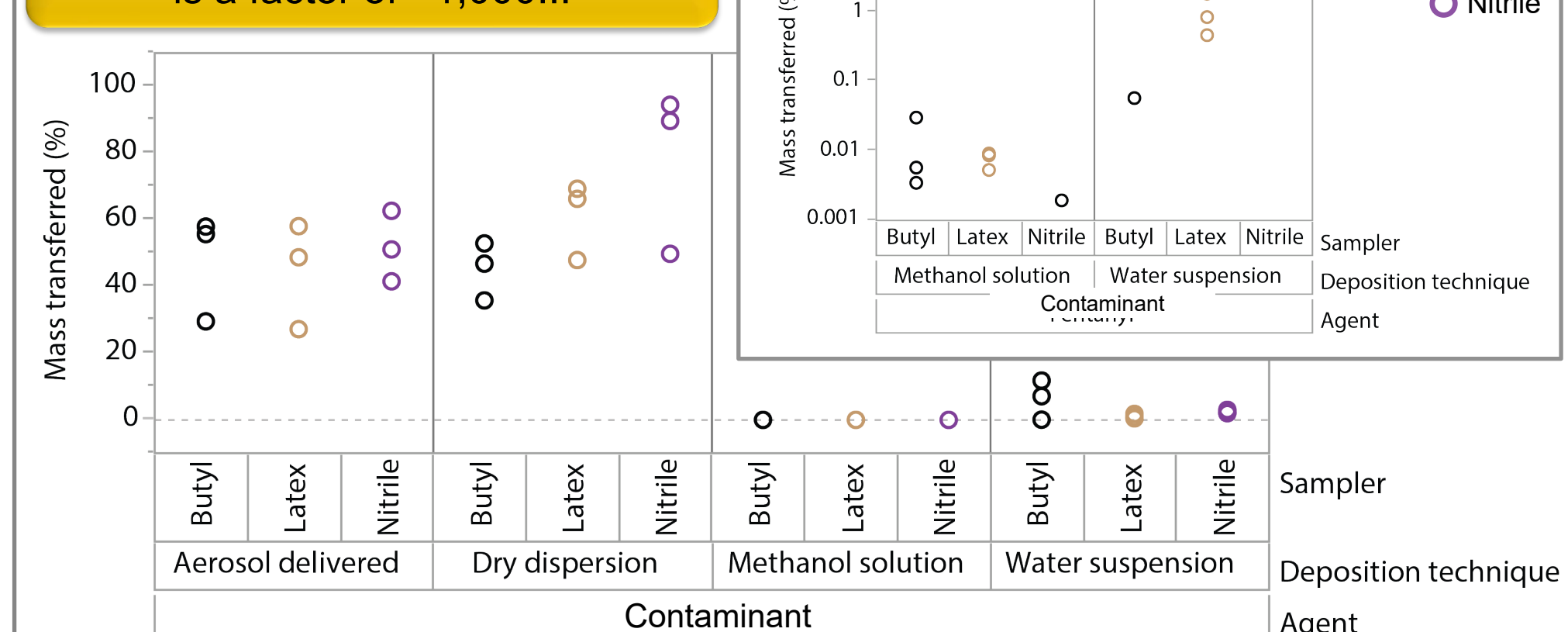
- Effect of deposition technique completely outweighs effect of PPE material.
- Primary observations based on drug form indicate significant deviations in solubility.
- Suggests that environmental manipulation (e.g., spraying) will impact contact transfer hazard, as well as ability to dampen inhalation hazard. Spraying may also form freebase – which may adhere to PPE, creating additional hazards.



Aerosol Dry

Removal Techniques and Effects

The transfer for wet vs. dry delivery is a factor of >1,000!!!



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