SAND2016-8427C

Exceptional service in the national interest

Sandia National Laboratories

LDRD LABORATORY DIRECTED RESEARCH & DEVELOPMENT

Not All Gloves are Created Equal

Kim M Archuleta, Elizabeth M Huffman

Abstract

To mitigate contamination risk in hardware assembly it is important to understand the interactions of materials with tools. With certain types of cleaning fluids, tools, such as gloves, may shed a high level of particulate or leave a residue of chemicals or mold release. For critical surface applications, small amounts of residue may cause unwanted issues. Measurement of liquid particle counts, NVR mass, and type of surface residue are investigated here for powder-free nitrile gloves, and for nitrile and latex cleanroom gloves. Cleaning agent submersion in ethanol and DI water, as well as dry glove transfer is presented. Results are dependent on the specific interaction, with more residues released from non-cleanroom gloves, but also relatively high particulate or relatively high chemical residue for cleanroom gloves is observed, depending on the fluid of exposure. The overall least amount of measured contamination is in use of white nitrile cleanroom gloves.

Background/Materials

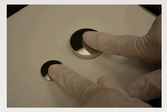
- Glove Contaminant Sources
  - Mold Release
  - Plasticizers
  - Anti-oxidation Chemicals
  - Slip Agents
  - Manufacturing Process Residue
  - Particulates
- Concerns
  - Light element contamination load
  - Oils, grease, waxes
  - Particulate
- Glove Types Tested:

Material	Cleanliness Level	Color
Nitrile	Powder-free exam	Blue
Nitrile	Powder-free exam	Green/Bright Green
Nitrile	ISO 5 Cleanroom	Blue
Nitrile	ISO 5 Cleanroom	White, 2 types
Nitrile	ISO 4 Cleanroom	Aqua
Latex	ISO 5 Cleanroom	Natural

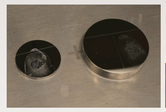
- Cleaning fluid for exposure
  - None (dry transfer)
  - Ethanol
  - DI Water

Method

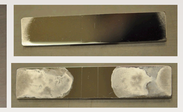
- Sample preparation
  - Stainless steel coupons cleaned
  - Tub cleaned; LPC counts verified
  - Dry transfer: glove finger tips pressed onto coupon
  - Solvent extraction: gloved hands submersed, manipulated for 5 seconds, submersed, repeat 5 times
- Wet touch transfer tests
  - Brief shake off of excess fluid
  - Press finger tips firmly to coupons



Application of touch transfer to 304 SS round coupons



Residue covers central area of coupon

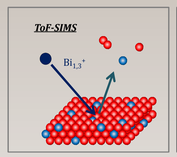


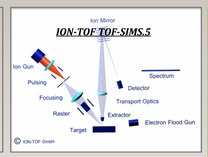
304 SS bar coupon, residue applied to opposite sides (mock sample)

- NVR, LPC and contact angle tests
  - 1 liter fluid for glove submersion
  - Glass slide dipped in stirred solution then blown dry for contact angle
  - LPC and NVR use 100 mL glover exposed submersion fluid
  - Fluid control applied (no glove submersion)

Analysis

- Surface Analysis of dry & wet contact transfer
  - Determine specific content of residue
  - ToF-SIMS (Time-of-Flight Secondary Ion Mass Spectrometry)
    - Negative ion fragments
    - Positive ion fragments
    - Elemental & Molecular fragments
    - High chemical specificity
    - Excellent trace metals detection
    - Reasonably fast
    - Large area chemical mapping

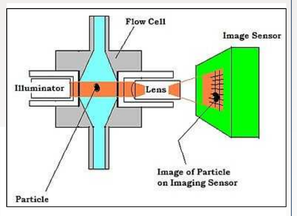




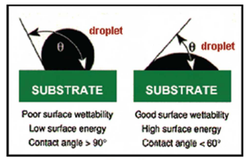
- Bombardment of surface by primary ion beam.
- Surface elementary or cluster ions fragment and volatilize.
- Separation by mass spectrometer.

- Effluent Analysis
  - Compare amount of residue left on parts after fluid submersion
  - NVR (Non Volatile Residue)
  - LPC (Liquid Particle Count)
  - Contact Angle (DI water droplet)

Aluminum NVR boat with dried residue



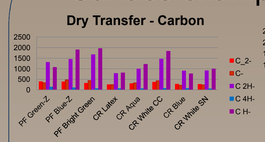
LPC diagram

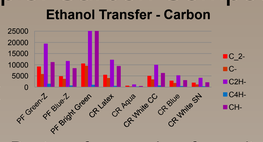


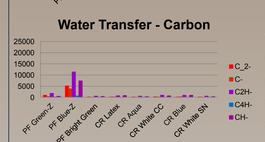
Contact angle description

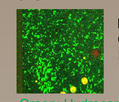
Results

- Surface example: Carbon Compounds







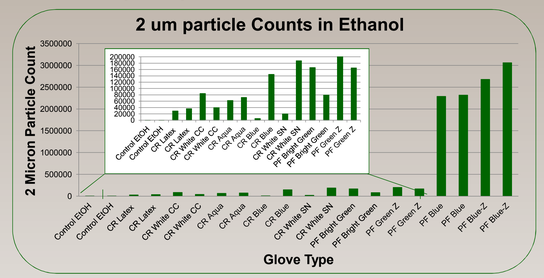


Bright Green Nitrile Exam

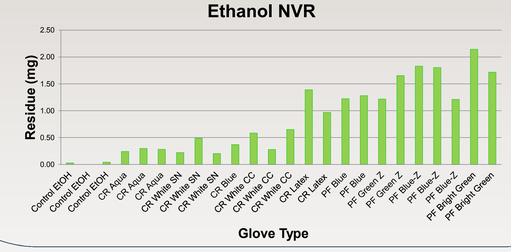
Green: Hydrocarbons; dry touch transfer

Dry transfer an order of magnitude lower than wet transfer, displaying highest amounts for PF Bright Green, PF Blue-Z and CR White CC. The largest change is increase in ethanol from PF Bright Green and PF Green-Z. PF Blue-Z show Cl in water and ethanol, PF Blue-Z and CR Latex in ethanol.

- LPC example: particles from ethanol



- NVR example: ethanol mass measurement



Conclusions

	Solvent Extraction: LPC	NVR	CA	Contact Transfer: Over All Load	Hydro-carbons	Sili-cones	Sulfur	Chlorine
PF Blue/Z	H	H	H	H	M	M	L	M
PF Green-Z	L	H	L	H	M	L	M	H
PF Br. Green	M	H	L	H	H	L	M	L
CR Latex	L	M	H	M	M	L	L	H
CR White CC	L	L	L	L	M	L	L	M
CR White SN	L	L	L	L	L	L	L	L
CR Aqua	L	L	M	L	L	L	L	L
CR Blue	L	L	H	L	L	L	L	L

H – Higher relative value
M – Median relative value
L – Lower relative value

Low chemical transfer: Cleanroom nitrile gloves

Low particle count: Cleanroom latex or nitrile gloves. *Caution choosing powder-free nitrile gloves*

Low NVR: Cleanroom nitrile

Good contact angle: White cleanroom nitrile

References: **Welker, Lehman**, Using contamination and ESD tests to qualify and certify cleanroom gloves (ESD, NVR and LPC tests, washing gloves for low particulate) MICRO 17, no. 5, 1999

Sovinski, Contamination of Critical Surfaces from NVR Glove Residues Via Dry Handling and Solvent Cleaning (NVR dry and with solvents, compared nitrile and latex brands; large nitrile variation seen) NASA/TM-2004-212752 2004

Flinn, Phariss, Ballien Improving Adhesive Bonding of Composites Through Surface Characterization (some brands of nitrile gloves leave residue that decrease surface energy), FAA AMTAS (Univ. of WA presentation) 2004

Patti, Lee, Castino, IR Spectroscopy Analysis of Disposable Gloves for Residues (silicones, phthalates, wax, stearate in various types), Spectroscopy* 2008 * spectroscopyonline.com

Strohmeier, Piasecki, Plasencia, XPS Surface Characterization of Disposable Laboratory Gloves and the Transfer of Glove Components to Other Surfaces (nitrile & latex, dry & chemical rinsed powder-free exam gloves; variability) S* 2012