Glove Contaminant Transfer Evaluation

Residue Analysis by FTIR and GC/MS

Purpose and Background

- Gloves are a source of contamination, especially when used with solvents
- Solvents will extract unwanted residues from gloves, and most materials
- This occurs during cleaning operations for spacecraft hardware
- Therefore, need for glove residue evaluation during cleaning operations

Purpose and Background Cont'd

- Typical glove residue analysis: donning of glove and rinse with solvent
- This evaluation focuses on the transfer of glove contaminant onto a plate surface during a typical cleaning operation
- Shows more accurate representation of what truly is occurring

Materials

- Approved clean room wipes (extracted)
- 1/16" thick, cleaned, 1sq ft aluminum panels
- Approved isopropyl alcohol
- Approved acetone
- Approved chloroform
- Latex gloves
- Nitrile gloves (blue)
- Nitrile glove (purple)
- Polyethylene gloves
- Clean sample pans
- Clean sample bottles
- Clean aluminum foil

Process

- Aluminum sample plates cleaned per internal witness plate cleaning procedure
- Performed "background" rinses of plates and obtained "background residue weights
- FTIR analysis of "background" residue
- Sample plates 1 through 10 prepared (typical cleaning with different gloves, two solvents and approved wipes)
- Residue weights, FTIR, GCMS analysis

Sample Plate "Background"
Rinse – FTIR Analysis

Plate 1) Trace hydrocarbons, barely detectable esters; 0.09mg

Plate 2) Trace hydrocarbons, barely detectable esters; 0.07mg

Plate 3) Trace hydrocarbons; 0.06mg

Plate 4) Small hydrocarbons; 0.09mg

Plate 5) Small hydrocarbons; 0.07mg

"Background" Rinse – FTIR Analysis cont'd

Plate 6) Trace hydrocarbons; 0.03mg

Plate 7) Small hydrocarbons; 0.08mg

Plate 8) Small hydrocarbons, trace esters; 0.12mg

Plate 9) Small hydrocarbons, trace esters; 0.11mg

Plate 10) Trace hydrocarbons, barely detectable esters; 0.07mg

Plate Rinse After Cleaning – FTIR Analysis

Plate 1) Latex gloves, isopropyl alcohol (IPA), wipe……. 0.53mg

Hydrocarbons, phenol based species

Plate 2) Latex gloves, acetone, wipe……..……..0.48mg

Phenol based species, hydrocarbons

Plate 3) Blue nitrile gloves, IPA, wipe……..0.11mg

Mostly polyester (from wipes), hydrocarbons

Plate Rinse After Cleaning – FTIR Analysis cont'd

Plate 4) Blue nitrile gloves, acetone, wipe……..0.22mg

Mostly polyester (from wipes), hydrocarbons

Plate 5) Purple nitrile gloves, IPA, wipe……0.12mg

Mostly polyester (from wipes), hydrocarbons

Plate 6) Purple nitrile gloves, acetone, wipe……..0.22mg

Mostly polyesters (from wipes), hydrocarbons

Plate Rinse After Cleaning – FTIR Analysis cont'd

Plate 7) Poly gloves over Latex gloves, IPA, wipe……0.14mg

Mostly amides (from poly gloves)

Plate 8) Poly gloves over Latex gloves, acetone, wipe……0.11mg

Polyesters (wipes), amides (poly gloves)

Plate 9) Poly gloves over blue nitrile gloves, IPA, wipe....0.15mg

Mostly amides (from poly gloves), polyesters (from wipes)

Plate 10) Poly gloves over blue nitrile, acetone, wipe…….0.12mg

Polyesters (wipes), amides (poly gloves)

GCMS Analysis

Plate 1: Surface Cleaned With IPA Wearing Latex Gloves

1. Mainly 2,2'-methylenebis(6-tert-butylphenol) – antioxidant from latex gloves

2. Squalene – handling contaminant

Plate 2: Surface Cleaned With Acetone Wearing Latex Gloves

1. Mainly 2,2'-methylenebis(6-tert-butylphenol) – antioxidant from latex gloves

2. Squalene – handling contaminant

GCMS Analysis cont'd

Plate 3: Surface Cleaned With IPA Wearing Blue Nitrile Gloves

1. Mainly various hydrocarbons
2. Di(2-ethylhexyl) phthalate (DEHP) – plasticizer
3. Palmitic acid – handling contaminant
4. Unknown ester
5. Dibutyl phthalate – plasticizer
6. Di(2-ethylhexyl) adipate – plasticizer

GCMS Analysis cont'd

Plate 4: Surface Cleaned With Acetone Wearing Blue Nitrile Gloves

1. Mainly various hydrocarbons
2. Decanal – possible handling contaminant
3. Organic acids including palmitic acid and myristic acid
4. Squalene – handling contaminant
5. Nonanal – possible handling contaminant
6. Di(2-ethylhexyl) phthalate (DEHP) – plasticizer
7. An unknown ester

GCMS Analysis cont'd

Plate 5: Surface Cleaned With IPA Wearing Purple Nitrile Gloves

1. Mainly various hydrocarbons
2. Nonanal – possible handling contaminant
3. Decanal – possible handling contaminant
4. Di(2-ethylhexyl) phthalate (DEHP) – plasticizer
5. Dibutyl phthalate – plasticizer
6. Di(2-ethylhexyl) adipate – plasticizer
7. Palmitic acid – handling contaminant

GCMS Analysis cont'd

Plate 6: Surface Cleaned With Acetone Wearing Purple Nitrile Gloves

1. Mainly various hydrocarbons
2. Nonanal – possible handling contaminant
3. Organic acids including palmitic acid and nonanoic acid
4. Di(2-ethylhexyl) phthalate (DEHP) – plasticizer
5. An amine
6. Dibutyl phthalate – plasticizer
7. An unknown ester

GCMS Analysis cont'd

Plate 7: Surface Cleaned With IPA Wearing Poly Gloves Over Latex Gloves

1. Mainly erucamide – slip agent from polyethylene

2. Hydrocarbons

Plate 8: Surface Cleaned With Acetone Wearing Poly Gloves Over Latex Gloves

1. Erucamide – slip agent from polyethylene

2. Trace hydrocarbons

3. Trace di(2-ethylhexyl) phthalate (DEHP) – plasticizer

GCMS Analysis cont'd

Plate 9: Surface Cleaned With IPA Wearing Poly Gloves Over Blue Nitrile Gloves

1. Mainly erucamide – slip agent from polyethylene

2. Nonanal – handling contaminant

3. Hydrocarbons

Plate 10: Surface Cleaned With Acetone Wearing Poly Gloves Over Blue Nitrile Gloves

1. Erucamide – slip agent from polyethylene

2. Trace hydrocarbons

3. Trace di(2-ethylhexyl) phthalate (DEHP) – plasticizer

Summary/Conclusions

- Higher amounts of residue from latex gloves/IPA or acetone
- Solvent exposure of latex mostly extracted phenol based antioxidants
- Lower amounts of residue with nitrile and poly gloves/IPA or acetone
- Solvent exposure of nitrile mostly extracted hydrocarbons and esters, and mostly extracted amides from poly gloves

Summary/Conclusions cont'd

- Solvent exposure of clean room wipes will breakdown polyester fabric
- Evidence from FTIR analysis, not seen on GCMS analyses, for polyester residue
- Soxhlet extraction of wipes will reduce residue amounts
- Recommend not to use latex for cleaning, only for "dry handling" of items

Summary/Conclusions cont'd

- Use nitrile gloves when performing general cleaning operations
- Don poly gloves over nitrile gloves for items that require "precision cleaning"
- Minimize use of solvents when possible
- Change gloves/wipes frequently
- Goal: Locate and evaluate "ultraclean" poly glove