Infrared Database for Process Support Materials

K.E. Bennett, R.E. Boothe, and H.D. Burns
Marshall Space Flight Center, Marshall Space Flight Center, Alabama

June 2003
The NASA STI Program Office...in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA Scientific and Technical Information (STI) Program Office plays a key part in helping NASA maintain this important role.

The NASA STI Program Office is operated by Langley Research Center, the lead center for NASA’s scientific and technical information. The NASA STI Program Office provides access to the NASA STI Database, the largest collection of aeronautical and space science STI in the world. The Program Office is also NASA’s institutional mechanism for disseminating the results of its research and development activities. These results are published by NASA in the NASA STI Report Series, which includes the following report types:

- **TECHNICAL PUBLICATION.** Reports of completed research or a major significant phase of research that present the results of NASA programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA’s counterpart of peer-reviewed formal professional papers but has less stringent limitations on manuscript length and extent of graphic presentations.

- **TECHNICAL MEMORANDUM.** Scientific and technical findings that are preliminary or of specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.

- **CONTRACTOR REPORT.** Scientific and technical findings by NASA-sponsored contractors and grantees.

- **CONFERENCE PUBLICATION.** Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or cosponsored by NASA.

- **SPECIAL PUBLICATION.** Scientific, technical, or historical information from NASA programs, projects, and mission, often concerned with subjects having substantial public interest.

- **TECHNICAL TRANSLATION.** English-language translations of foreign scientific and technical material pertinent to NASA’s mission.

Specialized services that complement the STI Program Office’s diverse offerings include creating custom thesauri, building customized databases, organizing and publishing research results...even providing videos.

For more information about the NASA STI Program Office, see the following:


- E-mail your question via the Internet to help@sti.nasa.gov

- Fax your question to the NASA Access Help Desk at (301) 621–0134

- Telephone the NASA Access Help Desk at (301) 621–0390

- Write to:
  NASA Access Help Desk
  NASA Center for AeroSpace Information
  7121 Standard Drive
  Hanover, MD 21076–1320
Infrared Database for Process Support Materials

K.E. Bennett, R.E. Boothe, and H.D. Burns
Marshall Space Flight Center, Marshall Space Flight Center, Alabama
TRADEMARKS

Trade names and trademarks are used in this report for identification only. This usage does not constitute an official endorsement, either expressed or implied, by the National Aeronautics and Space Administration.

Available from:

NASA Center for AeroSpace Information
7121 Standard Drive
Hanover, MD 21076–1320
(301) 621–0390

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
(703) 487–4650
# TABLE OF CONTENTS

1. INTRODUCTION ........................................................................................................................... 1

2. DESCRIPTION ............................................................................................................................... 2

3. RESULTS ........................................................................................................................................ 3

4. CONCLUSIONS ............................................................................................................................. 6

APPENDIX A—HORIZONTAL ATTENUATED TOTAL REFLECTANCE CRYSTAL ANALYZED PRODUCTS ................................................................. 7

APPENDIX B—NICOLET 750 ANALYZED SOLVENTS/LIQUIDS ......................................................... 9

APPENDIX C—DRY TRANSFERENCE TEST RESULTS .................................................................... 10

APPENDIX D—SURFACE OPTICS CORPORATION MODEL 400 SPECTROMETER ANALYZED PRODUCTS ........................................................................ 11

APPENDIX E—SOLVENT EXTRACTION TEST RESULTS ................................................................. 12
LIST OF FIGURES

1. Results of transference test shown by spectra of (a) residue from dry MAPA Professional Technic glove and (b) silicone fluid F-75 ................................................. 3

2. Results of transference test shown by spectra of (a) residue from dry Ansell Edmont glove and (b) paraffin wax ........................................................................... 4

3. Results of extraction test shown by spectra of (a) residue from denatured alcohol extraction of CRP orange nylon bagging material and (b) polyamide-11 .................. 4

4. Results of extraction test shown by spectra of (a) residue from TCA extraction of Rymple cloth and (b) wax dispersion ......................................................... 5

LIST OF TABLES

1. Process materials and residue detected ......................................................................... 10

2. Results from solvent extraction tests ........................................................................... 12
**LIST OF ACRONYMS**

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HATR</td>
<td>horizontal attenuated total reflectance</td>
</tr>
<tr>
<td>IR</td>
<td>infrared</td>
</tr>
<tr>
<td>MP&amp;M</td>
<td>Materials, Processes, and Manufacturing (Department)</td>
</tr>
<tr>
<td>MSFC</td>
<td>Marshall Space Flight Center</td>
</tr>
<tr>
<td>SOC-400</td>
<td>Surface Optics Corporation Model 400 Spectrometer</td>
</tr>
<tr>
<td>TCA</td>
<td>methyl chloroform</td>
</tr>
<tr>
<td>TM</td>
<td>Technical Memorandum</td>
</tr>
</tbody>
</table>
TECHNICAL MEMORANDUM

INFRARED DATABASE FOR PROCESS SUPPORT MATERIALS

1. INTRODUCTION

Process support materials’ compatibility with cleaning processes is critical to ensure final hardware cleanliness and that performance requirements are met. Previous discovery of potential contaminants in process materials shows the need for incoming materials testing and establishment of a process materials database. The Contamination Control Team of the Materials, Processes, and Manufacturing (MP&M) Department at Marshall Space Flight Center (MSFC) has initiated the development of such an infrared (IR) database, called the MSFC Process Materials IR database, of the common process support materials used at MSFC. These process support materials include solvents, wiper cloths, gloves, bagging materials, etc. Testing includes evaluation of the potential of gloves, wiper cloths, and other items to transfer contamination to handled articles in the absence of solvent exposure, and the potential for solvent exposure to induce material degradation. This Technical Memorandum (TM) summarizes the initial testing completed through December 2002. It is anticipated that additional testing will be conducted with updates provided in future TMs.
2. DESCRIPTION

Materials were analyzed using two different IR techniques: (1) Dry transference and (2) liquid extraction testing. The first of these techniques utilized the Nicolet Magna 750 IR spectrometer outfitted with a horizontal attenuated total reflectance (HATR) crystal accessory. The region from 650 to 4,000 wave numbers was analyzed, and 50 scans were performed per IR spectrum. A dry transference test was conducted by applying each sample with hand pressure to the HATR crystal to first obtain a spectrum of the parent material. The material was then removed from the HATR crystal and analyzed to determine the presence of any residues. If volatile, liquid samples were examined both prior to and following evaporation. A list of materials tested by the dry transference technique can be found in appendix A; the liquid samples analyzed are listed in appendix B. Dry transference test results are shown in appendix C.

The second technique was to perform an extraction test with each sample in five different solvents. The materials used for extraction testing were those most common in MP&M laboratories and the substore in building 4707. A list of these materials can be found in appendix D. The extraction residues were scanned using a Surface Optics Corporation 400 spectrometer (SOC–400) outfitted with a V-sphere analysis accessory. The analysis region for this instrument was 650 to 4,000 wave numbers, and 32 scans were performed per IR spectrum. Each sample material was tested a total of 10 times (2 exposure periods with each of the 5 solvents). For the first portion of the test, a sample would be agitated in the solvent for 10 s in a glass jar. The solvent would then be added to the V-sphere cup, allowed to evaporate, and then scanned. For the second exposure period, a sample would be placed in a glass jar with the solvent for a total of 1 hr. The solvent would then be added to the V-sphere cup, allowed to evaporate, and then scanned. Extraction test results are shown in appendix E.

Once the scans were complete for both the dry transference and the extraction tests, the residue from each scan was interpreted. Several very significant findings were made using both techniques.
3. RESULTS

Dry transference testing was important for all materials since gloves are used for handling, wiper cloths can be used for dry cleaning, and plastic forms are used for bagging contact hardware. Glove selection is critical since direct contact with sensitive hardware occurs during handling. Two gloves tested using the transference test were found to contain a silicone coating. A few different lots of each of these gloves were tested to determine the accuracy of the findings. The gloves found to include the silicone residue were the MAPA Professional Technic® glove and the Microflex® Ultra One® latex glove. In each case it is believed that the silicone is a coating on the glove and not a degradation product or glove particulate. Spectra of the MAPA Professional Technic glove residue and a common silicone are shown in figure 1.

![Figure 1. Results of transference test shown by spectra of (a) residue from dry MAPA Professional Technic glove and (b) silicone fluid F-751.](image)

Residue collected from dry transference testing of Ansell Edmont gloves was shown to be consistent with a hydrocarbon wax such as paraffin (fig. 2). This residue is believed to be a coating on the glove and not a degradation product or glove particulate.
Extraction testing was conducted on wiper cloths, gloves, and other materials that might come in contact with solvents or solutions during cleaning processes or by inadvertent contact. The extraction testing found several significant findings as well. Tests completed on CRP orange nylon bagging material with the solvents alcohol, methyl chloroform (TCA), and acetone produced a polyamide. Dry transference testing performed on the bagging material resulted in no residue observed. This comparison indicates that the residue is a degradation product of the material. Spectra of the extraction residue and a common polyamide are shown in figure 3.

Figure 2. Results of transference test shown by spectra of (a) residue from dry Ansell Edmont glove and (b) paraffin wax.

Figure 3. Results of extraction test shown by spectra of (a) residue from denatured alcohol extraction of CRP orange nylon bagging material and (b) polyamide–11.
Another finding from the extraction testing is that exposure of Rymple cloth to TCA and alcohol residue produces a hydrocarbon wax residue. When performing dry transference testing on the HATR crystal, the residue from the Rymple cloth was a fiber residue, indicating that the extraction residue is a degradation product. Spectra of the Rymple cloth residue and a common hydrocarbon wax are shown in figure 4.

Figure 4. Results of extraction test shown by spectra of (a) residue from TCA extraction of Rymple cloth and (b) wax dispersion.
4. CONCLUSIONS

The test results summarized in this TM illustrate that many process support materials in use in MSFC laboratories have the potential to transfer contamination to items with which they come into contact. This is particularly true if the material is used in conjunction with a solvent. Continued cataloguing of processing materials will increase the likelihood that unknown contaminants found on bonding, optical, and other surfaces can be accurately identified. The database can also serve as a reference to help determine how or whether processing materials should be used for specific applications.
APPENDIX A—HORIZONTAL ATTENUATED TOTAL REFLECTANCE CRYSTAL ANALYZED PRODUCTS

The following are products analyzed using the HATR crystal accessory:

Gloves:
- Ansell Chem-White™ glove
- Ansell Edmont Chem-White™ Sol-Vex® nitrile glove 37–105
- Ansell Edmont Sol-Vex® glove 9323A 37–155 8
- Ansell Nitrilite® gloves lot 0103501008
- Berkshire BCR® glove liner
- Cotton glove insert
- MAPA Pioneer Stanzoil® neoprene glove
- MAPA Professional Technic® glove NS–35
- Microflex® Ultra One® glove
- ORS treated industrial glove RN67368

Wipers:
- Anticon 100® wiper cloth by Milliken Research Corporation
- Anticon 100® with Plus-4 premoistened wiper cloth by Milliken Research Corporation
- Chix® TM aerospace wiper
- Contec® wiper
- Horizon tech wipe 530/5353
- Merocel® wiper cloth 900284
- Multigraphics® Multilith® pads 200–847
- PF degreaser solvent wiper
- Rippey wiper cloth
- Ross optical lens tissue
- Rymple cloth
- Vera Clean premoistened actone wipes lot 071902

Brushes:
- Maxwell Corp. of America 2-in foam brush
- Sponge brush 828265
- Tynex brush part No. 01–004210–001

Cleaners:
- Blue Gold industrial cleaner by Modern Chemical Inc.
- ChemCo 030 white titanium dioxide LS06838
- Cole-Parmer lab cleaning solution series 8790
- DIF hand cleaner type 1C12 grade B
Miscellaneous:
2100 blue side
2100 brown side
Brown paper
Capran® 980
Cotton-tipped applicator
CRC Power Lube®
CRP orange nylon bag
DoAll rust preventive
DOW Corning® RTV sealant
Kapton® H
Polyethylene bag
Silikroil® by Kano Laboratories
TechSpray Envi-ro-tech™ circuit chiller 1672
TriFlow mold release by Krylon
WD-40®
APPENDIX B—NICOLET 750 ANALYZED SOLVENTS/LIQUIDS

The following are solvents and liquids analyzed using the Nicolet 750 spectrometer configured as described in section 2:

Blue Gold industrial cleaner by Modern Chemical Inc.
Cole-Parmer lab cleaning solution series 8790
Dichloromethane alpha
E-Z lacquer thinner
Fisher Scientific methyl ethyl ketone UN1193
HFE-7100 Novec, 3M lot 24132
Humco Isopropyl Rubbing Alcohol 70% USP
Klean-Strip S-L-X denatured alcohol
Lacquer thinner
Mallinckrodt acetone SpectraR 2438
Methyl ethyl ketone
PF degreaser
RE-ENTRY® Plus-4 by Petroferm Inc.
Silquest A-187
Toluene
Xylene dyce
APPENDIX C—DRY TRANSFERENCE TEST RESULTS

Table 1 shows process materials used and whether residue was detected as a result of dry transference testing.

Table 1. Process materials and residue detected.

<table>
<thead>
<tr>
<th>Process Material</th>
<th>Residue Detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>2100 blue side</td>
<td></td>
</tr>
<tr>
<td>2100 brown side</td>
<td></td>
</tr>
<tr>
<td>Ansell Chem-White glove</td>
<td></td>
</tr>
<tr>
<td>Ansell Edmont gloves</td>
<td>X</td>
</tr>
<tr>
<td>Ansell Edmont Sol-Vex glove 9323A 37–155 8</td>
<td></td>
</tr>
<tr>
<td>Ansell Nitrilite gloves</td>
<td></td>
</tr>
<tr>
<td>Anticon 100 wiper cloth by Milliken Research Corp.</td>
<td></td>
</tr>
<tr>
<td>Anticon 100 wiper with Plus 4 by Milliken Research Corp.</td>
<td></td>
</tr>
<tr>
<td>Berkshire BCR glove liner</td>
<td>X</td>
</tr>
<tr>
<td>Brown paper</td>
<td></td>
</tr>
<tr>
<td>Capran 980</td>
<td></td>
</tr>
<tr>
<td>Chix TM aerospace wiper</td>
<td></td>
</tr>
<tr>
<td>Contec wipe</td>
<td></td>
</tr>
<tr>
<td>Cotton glove insert</td>
<td>X</td>
</tr>
<tr>
<td>Cotton-tipped applicator</td>
<td></td>
</tr>
<tr>
<td>CRC Power Lube</td>
<td>X</td>
</tr>
<tr>
<td>CRP orange nylon bag</td>
<td></td>
</tr>
<tr>
<td>DoAll rust preventive</td>
<td></td>
</tr>
<tr>
<td>Horizon tech wipe 5350/5353</td>
<td></td>
</tr>
<tr>
<td>Kapton H</td>
<td></td>
</tr>
<tr>
<td>MAPA Pioneer Stanzoil neoprene glove NS–35</td>
<td></td>
</tr>
<tr>
<td>MAPA Professional Technic glove NS–35</td>
<td></td>
</tr>
<tr>
<td>Maxwell Corp. of America 2-in foam brush</td>
<td></td>
</tr>
<tr>
<td>Mercol wiper cloth 900264</td>
<td></td>
</tr>
<tr>
<td>Microflex Ultra One glove</td>
<td></td>
</tr>
<tr>
<td>Multigraphics Multilith pads</td>
<td></td>
</tr>
<tr>
<td>ORS treated industrial glove RN57368</td>
<td></td>
</tr>
<tr>
<td>PF degreaser solvent wiper</td>
<td></td>
</tr>
<tr>
<td>Polyethylene bag</td>
<td></td>
</tr>
<tr>
<td>Rippey wiper cloth</td>
<td></td>
</tr>
<tr>
<td>Ross optical lens tissue</td>
<td></td>
</tr>
<tr>
<td>Silikroil by Kano Laboratories</td>
<td></td>
</tr>
<tr>
<td>Sponge brush 828265</td>
<td></td>
</tr>
<tr>
<td>TriFlow mold release by Krylon</td>
<td></td>
</tr>
<tr>
<td>Tynex brush part No. 01–004210–001</td>
<td></td>
</tr>
<tr>
<td>Vera Clean acetone wipes</td>
<td></td>
</tr>
<tr>
<td>WD–40</td>
<td></td>
</tr>
</tbody>
</table>

X = Dry transference residue
APPENDIX D—SURFACE OPTICS CORPORATION MODEL 400 SPECTROMETER
ANALYZED PRODUCTS

The following are products analyzed in liquid extraction testing using the SOC–400 spectrometer configured as described in section 2:

Solvents used:
- Acetone
- Denatured alcohol
- Ethanol
- Isopropyl alcohol
- TCA

Products analyzed:
- 2100 (brown and blue sides)
- Ansell nitrile glove lot 0103501008
- Ansell Sol-vex
- Ansell Sol-vex 9323A 37–1558 0493
- Anticon 100 wiper by Milliken Research Corporation
- Capran 980
- Clean class PFLT203 lot 4587
- Contec wiper
- CRP orange nylon bag
- Horizon tech wipes 5350/5353
- Kapton H
- MAPA Pioneer Stanzoil neoprene glove NS–35
- Merocel wiper cloth 900284
- Microflex latex glove
- Microflex Ultra One glove UL–315–XL
- Multigraphics Multilith pads 200–847
- Polyethylene bag
- Rippey wiper cloth
- Ross optical lens tissue
- Rymple cloth
APPENDIX E—SOLVENT EXTRACTION TEST RESULTS

Results from solvent extraction tests are shown in table 2.

Table 2. Results from solvent extraction tests.

<table>
<thead>
<tr>
<th>Process Material</th>
<th>Solvent</th>
<th>Acetone</th>
<th>Denatured Alcohol</th>
<th>Ethanol</th>
<th>Isopropyl Alcohol</th>
<th>TCA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>10 s</td>
<td>1 hr</td>
<td>10 s</td>
<td>1 hr</td>
<td>10 s</td>
</tr>
<tr>
<td>2100 Bagging material</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ansell nitrile glove</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ansell Sol-vex glove</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Anticon 100 wiper cloth</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Capran 980</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean class glove</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Contec wiper cloth</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>CRP nylon bagging material</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Horizon tech wipe</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Kapton H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAPA Pioneer Stanzoil neoprene glove</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Merocel wipe cloth</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Microflex latex gloves</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Microflex Ultra One latex glove</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Multigraphics Multilith pads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polyethylene bag</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Rippey wipe cloth</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ross optical lens tissue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rymple cloth</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

X = Extraction residue observed
In order to help identify contamination found on bonding surfaces, optical surfaces, or other items, the Materials Contamination Team of the Materials, Processes, and Manufacturing Department at Marshall Space Flight Center (MSFC) has initiated the development of an infrared database containing MSFC process materials and residues. Process materials analyzed to date using infrared spectroscopy for transferable and extractable contamination have included gloves, wiper cloths, solvents, bagging materials, etc. Significant findings included silicone contamination on several gloves and observations of extractables from the majority of materials tested.