

CLEANING LABORATORY EVALUATION SUMMARY

SCL #: 2001
 DateRun: 10/08/2001
 Experimenters: Jason Marshall
 ClientType: Electronics Manufacturer
 ProjectNumber: Project #1
 Substrates: Ceramics
 PartType: Coupon
 Contaminants: Abrasive, Coatings, Waxes
 Cleaning Methods:
 Analytical Methods:
 Purpose: Summary of Findings
 Experimental Procedure:

Results: Phase 1 Laboratory Testing
 The focus of the first project was to identify a replacement cleaner for toluene to remove wax. A total of sixteen products were evaluated using immersion cleaning. Through visual and gravimetric analysis, four cleaning products were found to be successful in removing the wax from the ceramic and glass substrates and are listed below in Table 1.

Table 1. Successful Wax Cleaning

| Company | Product | Classification | Efficiency |
|-----------------------|-----------------|---------------------|------------|
| Envirosolutions Inc | Bio T Max | Natural Terpene | 99.36 |
| Solvent Kleene | D Greeze 500 LO | Hydrocarbon Solvent | 76.16 |
| Buckeye International | Shopmaster RC | Ester blend | 87.89 |
| Universal Photonics | Uni Clear I | D-limonene Terpene | 100.01 |

Phase 2 Laboratory Testing
 Having found a replacement for toluene in wax removal, the next step was to find alternative cleaners for the other contaminants used at the facility. The use of the first of the contaminants was as an adhesive to be used in place of the current wax. The last two contaminants were both polishing slurries used during the initial stages of manufacturing of the ceramic base materials.

Cyrstalbond 509
 In an attempt to limit the amount of cleaning products, the successful wax cleaners were selected for evaluated for cleaning during this phase of testing. Only one of the cleaners was successful in removing the Crystalbond 509 adhesive. Shopmaster RC removed 94.83%. Additional products were also investigated for the removal of the Crystalbond 509. A total of twelve products were evaluated. Table 2 lists the successful cleaners for the 509 adhesive.

| Company | Product | Classification | Efficiency |
|-----------------------|---------------|----------------------|------------|
| Buckeye International | Shopmaster RC | Ester blend | 94.83 |
| DuPont | DBE-4 | Ester blend | 99.61 |
| Ecolink Inc. | Safe Strip | N-methyl pyrrolidone | 98.97 |
| Alconox Inc. | Luminox | Neutral Aqueous | 97.49* |

*Required 20 minutes additional cleaning time

Nalco Chemical Co Nalco 2350 Polishing Slurry
 Again, an attempt was made to evaluate the successful cleaners from the previous trials for the next contaminant. None of the previous products were capable of removing a majority of the polishing slurry from the ceramic coupons. Several alkaline aqueous products were found to very effective in removing nearly all of the slurry with fifteen minutes of soaking at 120 F. Table 3 lists the effective products.

Table 3. Nalco Chemical Co Nalco 2350 Polishing Slurry Cleaning

| Company | Product | Classification | Efficiency |
|---------------------|---------------|------------------|------------|
| Innovative Organics | Amberclean LC | Alkaline Aqueous | 99.72 |

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| International Products | Micro 90 | Alkaline Aqueous | 99.38 |
| LPS Industries | LPS Precision | Alkaline Aqueous | 99.50 |
| MacDermid | ND 17 | Alkaline Aqueous | 99.62 |
| Oakite Products | Inproclean 3800 | Alkaline Aqueous | 99.36 |
| US Polychemical | Polyspray Jet790 xs | Alkaline Aqueous | 99.42 |
| Amax | Safety First | Semi-aqueous Terpene | 99.88 |

Saint Gobain Industrial Ceramics Water Based Alumina

The same seven cleaners were also effective in cleaning the second polishing slurry, removing over 94% of the alumina from the ceramic coupons in five minutes of cleaning. ND 17 and LPS were the most effective removing just over 97%. The results are listed in Table 4.

Table 4. Saint Gobain Industrial Ceramics Water Based Alumina Cleaning

| Company | Product | Classification | Efficiency |
|------------------------|---------------------|----------------------|------------|
| Innovative Organics | Amberclean LC | Alkaline Aqueous | 94.50 |
| International Products | Micro 90 | Alkaline Aqueous | 94.11 |
| LPS Industries | LPS Precision | Alkaline Aqueous | 97.30 |
| MacDermid | ND 17 | Alkaline Aqueous | 97.31 |
| Oakite Products | Inproclean 3800 | Alkaline Aqueous | 94.24 |
| US Polychemical | Polyspray Jet790 xs | Alkaline Aqueous | 95.84 |
| Amax | Safety First | Semi-aqueous Terpene | 95.09 |

Phase 3 FTIR Analysis of Rejected Parts

The final project conducted at the lab was to determine the source of the contamination on rejected parts. The lab used Fourier Transform Infrared Spectrometry in an attempt to identify the possible contaminants on the ceramic and gold pieces. Fourier Transform Infrared spectroscopy correlates vibrational energy to a compound's molecular signature. Similar to other high-tech methods such as GC (gas chromatography), the curves generated in this analytical technique are both quantitative for species identification (the placement of the curve on the electromagnetic spectrum) and qualitative for amounts (the area under the curve). Interpretation of graphs can be difficult due to the presence of interfering peaks.

It appears that several of the supplied contaminated parts did have some of the wax remaining on them after the toluene cleaning. In addition most of the parts had toluene residue as well. The FT-IR readings made by SCL should not be considered as a final determination as to the identification of the source of contamination. Comparisons are listed in Table 5.

Table 5. FTIR Analysis

| Sample | Source | Observations-Comparison |
|--------|--------|---------------------------|
| 1 | A | Toluene |
| 2 | A | Toluene |
| 3 | B | Toluene & IPA & maybe Wax |
| 4 | B | Wax & Toluene |
| 5 | C | Wax & IPA |
| 6 | C | Wax & IPA |
| 7 | D | Wax & Toluene |
| 8 | A | Wax & Toluene |

Vendor Contact Information

Company names, contact numbers and addresses are listed in Table 6.

Table 6. Contact Information for Successful Cleaning Chemistries

| COMPANY | CONTACT Number | ADDRESS | LOCATION | STATE | ZIP |
|-------------|-----------------------|--------------------|------------|-------|-------|
| Alconox Inc | 1-212-532-4040 x60 | 9 East 40th Street | New York | NY | 10016 |
| | 1-800-662-0023 | | Louisville | KT | 40203 |

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|-----------------------------|----------------|--------------------------|------------------|----|-------|
| Amax Corporation | | 960 S. Third Street | | | |
| Buckeye International Inc | 1-314-291-1900 | 2700 Wagner Place | Maryland Heights | MO | 63043 |
| DuPont Nylon | 1-800-231-0998 | | Wilmington | DE | 19898 |
| Ecolink Inc | 1-800-886-8240 | 1481 Rock Mountain Blvd. | Stone Mountain | GA | 30083 |
| EnviroSolutions Inc | 1-203-452-7225 | 232 Main Street | Monroe | CT | 06468 |
| Innovative Organics | 1-714-701-3900 | 4790 East Wesley Drive | Anaheim | CA | 92807 |
| International Products Corp | 1-609-386-8770 | P.O. Box 70 | Burlington | NJ | 08016 |
| LPS Laboratories Inc | 1-800-241-8334 | 101 Stagecoach Dr. | Lancaster | MA | 01523 |
| MacDermid Inc | 1-203-575-5726 | 245 Freight Street | Waterbury | CT | 06702 |
| Oakite Products Inc | 1-908-508-2107 | 50 Valley Road | Berkeley Heights | NJ | 07922 |
| Solvent Kleene Inc | 1-978-531-2279 | 131 1/2 Lynnfield Street | Peabody | MA | 01960 |
| Universal Photonics | 1-516-935-4000 | 495 West John Street | Hicksville | NY | 11801 |
| US Polychemical Corp | 1-800-356-5530 | 584 Chestnut Ridge Road | Chestnut Ridge | NY | 10977 |

Summary:

Conclusion: