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Evaluation of Alkaline Cleaner Materials

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Topic areas: Degreasers and cleaning agents, Lessons learned

Alkaline cleaners used to process aluminum substrates have contained chromium as the corrosion inhibitor. Chromium is a hazardous substance whose use and control are described by environmental laws. Replacement materials that have the characteristics of chromated alkaline cleaners need to be found that address both the cleaning requirements and environmental impacts.

This report will review environmentally friendly candidates evaluated as non-chromium alkaline cleaner replacements and methods used to compare those candidates one versus another. The report will also list characteristics used to select candidates based on their declared contents. It will also describe and evaluate methods used to discriminate among the large number of prospective candidates.

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Evaluation of Alkaline Cleaner Materials

- Current product contains chromium
- Waste must be classified hazardous
- Health and safety are issues

Evaluation of Alkaline Cleaner Materials

- Sources of alternatives
 - Trade Journals
 - Internet sources
 - Conventional wisdom
- Attributes of alternatives
 - Free of chromium
 - Contain no silicate or silicone
 - Have low/no VOC content
 - Contain no EDTA
 - Applicable to immersion and spray processing
 - Process aluminum 2219 alloy without adverse affects

Evaluation of Alkaline Cleaner Materials

- Applications of current product
 - Air-agitated immersion
 - Low pressure mist spray
 - Hand application in rework
 - Aluminum 2219 and 2195 alloys
 - Titanium and Stainless Steel

Evaluation of Alkaline Cleaner Materials

- Selected 20 alternative candidates for testing
- Challenged each against five common processing contaminants
 - CRC 2-26 oil (hydrocarbon - low solubility parameter)
 - Blasocut, Lubricool (Machining aids - low solubility parameter)
 - Saftap (medium solubility parameter)
 - J 414 low residue tape (low solubility parameter)

Evaluation of Alkaline Cleaner Materials

- | | |
|--|---|
| ■ Air-agitated immersion test | ■ Low pressure mist spray test |
| – Lab scale | – Pilot scale |
| – Water break free in 10 min. / 30 min. | – Water break free 10 min. spray |
| – No staining/smutting | – No staining/smutting |
| – Visually clean | – Visually clean |
| – No residue by XPS (X-ray Photoelectron Spectroscopy) | – No residue by XPS |
| – Successful primer adhesion | – Successful primer adhesion |
| | – Acceptable <u>S</u> uper <u>L</u> ight <u>A</u> blator adhesion |

Evaluation of Alkaline Cleaner Materials

- Pitfalls in evaluation
 - Water break free analysis deceptive
 - Primer composition forgiving
 - SLA cryoflex adhesion does not discriminate

Evaluation of Alkaline Cleaner Materials

- Water break free analysis deceptive
 - Inorganic salts form hydrophilic surface; false positives
 - Silicates, chloride salts, copper hydroxides
 - Dehydrated oxides are not water break free; false negatives
 - Thin oil layers form hydrophobic surfaces; no affect on adhesive performance

Evaluation of Alkaline Cleaner Materials

- Primer composition forgiving
 - VOC content overcomes organic surface contaminants
 - oils and silicones
 - Adhesion promoter content aids contaminant compatibility

Evaluation of Alkaline Cleaner Materials

- SLA cryoflex adhesion does not discriminate
 - Primer adhesion exceeds the low temperature applied stress
 - Contaminant level does not affect adhesion

Evaluation of Alkaline Cleaner Materials

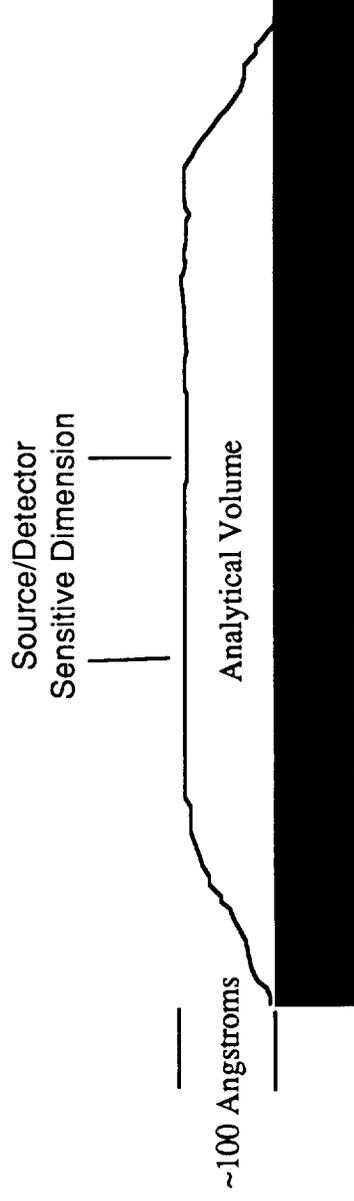
- XPS analysis only means to discriminate among cleaner candidates
 - Exceeds visually clean criteria

Evaluation of Alkaline Cleaner Materials

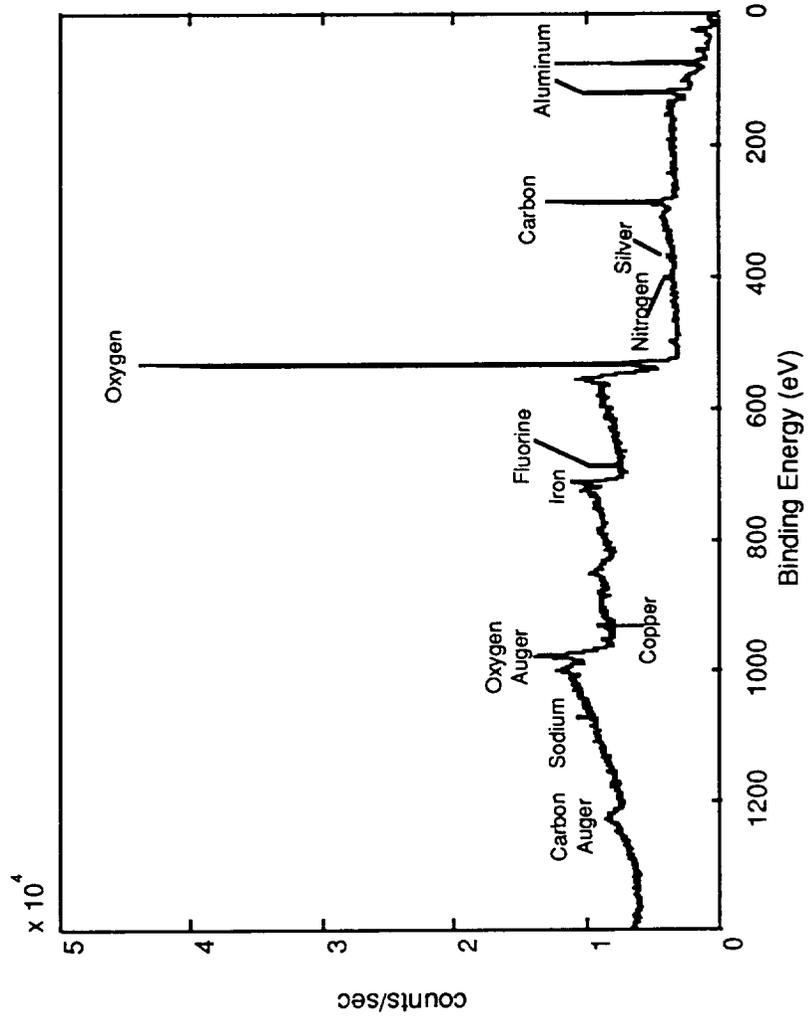
- XPS analysis definitive measure of cleaning
 - Interrogates outer volume of surfaces
 - Destructive - UHV compatible sample; reduced in size
 - Differentiates among elements and bonds in molecules
 - Quantitative

Evaluation of Alkaline Cleaner Materials

- XPS interrogates the outer volume of a surface about 100 Angstroms in thickness

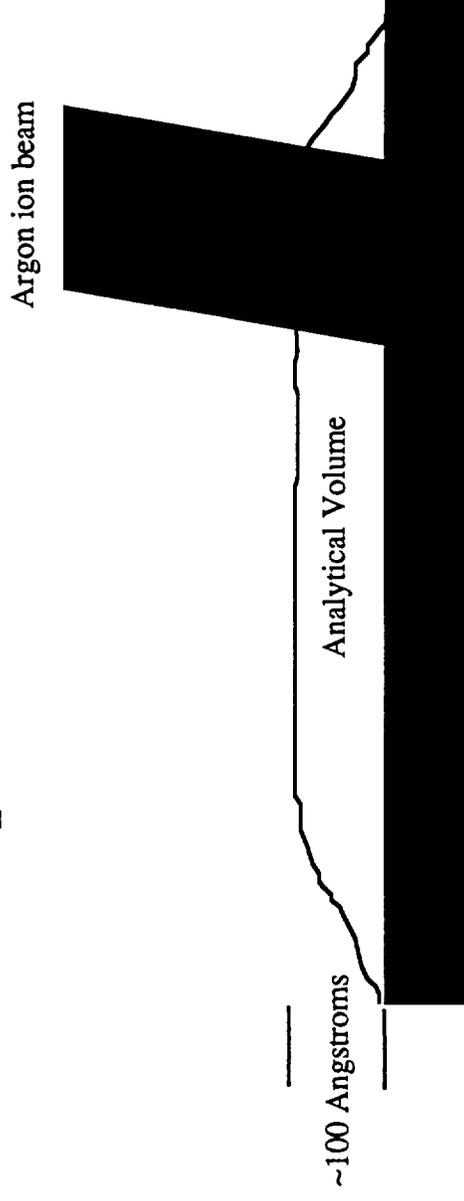


Evaluation of Alkaline Cleaner Materials

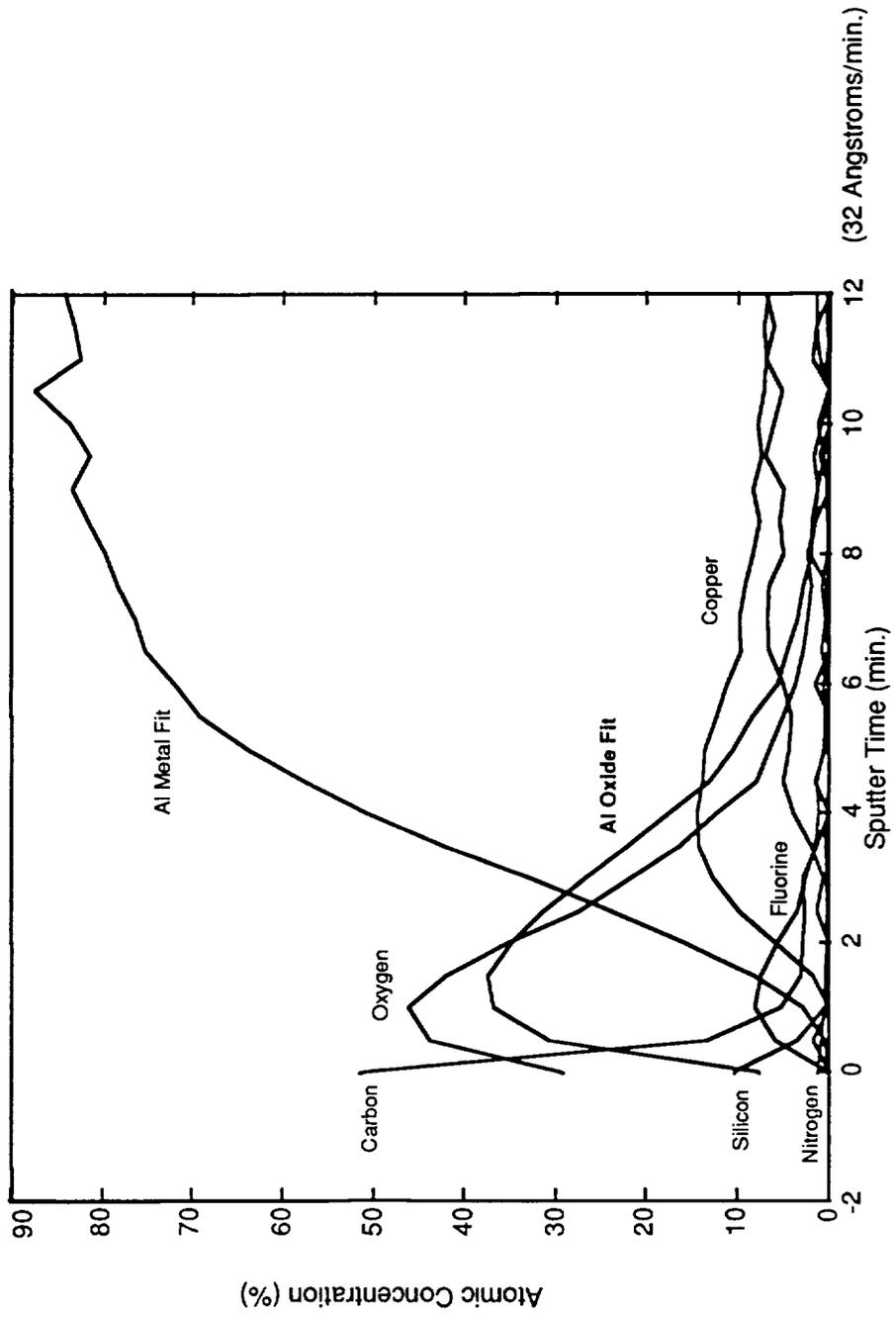


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- XPS in combination with depth profiling (ion milling) can evaluate entire bonding volume and substrate composition



Evaluation of Alkaline Cleaner Materials



Evaluation of Alkaline Cleaner Materials

| Cleaner | Contaminant | C | O | Al | F | Si | P | Cl | S | Fe | Cu | Ag | Al ₂ p/O ₁ s | N | Na |
|-----------------|-------------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|------------------------------------|-----|-----|
| Fremont 771L | Safe Tap | 23.7 | 47.7 | 20.6 | 0.7 | 6.1 | | | | | | | 0.65 | 1.2 | |
| FO 2213 | Safe Tap | 27.9 | 42.3 | 26.1 | | | | | | | 3.1 | 0.6 | 0.93 | | |
| NAB 9000 FS | Safe Tap | 40.4 | 34.0 | 21.2 | 1.8 | | | | | 2.7 | | | 0.94 | | |
| PC 820 PCA89 | Safe Tap | 31.7 | 43.5 | 19.6 | 0.8 | | 0.7 | | 2.5 | 0.9 | | | 0.68 | | 0.2 |
| PC 826 PCA89 | Safe Tap | 28.0 | 46.7 | 22.6 | | | 1.0 | 0.6 | | | 1.2 | | 0.72 | | |

- Fremont material contained Silicone in formulation
- Fremont and PC 826 products deposited copper on the surface
- Fremont and PC 820 products produced best oxide (Al₂O₃ ratio theo. 0.666/1)

Evaluation of Alkaline Cleaner Materials

- **Conclusions**
 - All candidates successful using traditional evaluation methods
 - Traditional methods miss underlying problems
 - Deposition of foreign material or process products