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Industry Session #: Reliability

Keeping Electronics Reliable When Disinfecting Factories for COVID-19

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OVERVIEW

- **The Virus**
- **Factory Situation**
- **iNEMI Sprint Project**
- **Collaboration among many**
- **Conclusions**
- **Guidance**

The Virus

- SARS-CoV-2 virus that causes COVID-19 led to a pandemic throughout 2020 and into 2021.
- There were shutdowns of factories all over the world to curb the spread of the disease.
- In order to re-start manufacturing, factories disinfected their facilities.
- Electronic products and the equipment in electronics manufacturing facilities, such as used for assembly and test, can be quite expensive and sensitive to corrosion.

Methods for Disinfection

- **Hand-wiping**
- **UV light**
- **Spraying**
- **Fogging**

Hand-wiping and UV

- **Hand-wiping**
  - Labor intensive
  - Time-consuming
  - Inconsistent
  - Drips could enter the equipment
- **UV light**
  - We did not find specific parameters for sufficient ultraviolet light disinfection.
  - The effect on electronics is likely minimal, and would only affect the exteriors, which are usually rated for some uv exposure.
  - We did not cover this method in the best practices.

Fogging / spraying

- **Spraying disinfectant is common in hospitals and food/beverage facilities.**
- **Fogging is a “dry” process where the droplet size is very small and leaves a microfilm that dries quickly.**

https://www.holchem.co.uk/divisions/brewery-and-beverage/techniques/aerial-disinfection/

Effect of Disinfection on Equipment

- Electronics manufacturers were concerned about the effect on their products.
- Factories asked manufacturing and test equipment manufacturers whether these techniques would be detrimental to the equipment.

What was heard:

- Is it ok for us to spray your equipment with corrosive chemicals, and will you still cover the warranty or service agreement?

Reaction:

- As individual companies, some had an initial response that the factory must turn off the equipment (so fans would not pull in the chemicals) and cover with plastic before spraying or fogging.
- With increasing questions and alarm at the impact, we banded together through iNEMI to create a consolidated response.

iNEMI Mission

Forecast and Accelerate improvements in the Electronics Manufacturing Industry for a Sustainable Future via Collaborative Innovation

Roadmap	• Anticipate technology requirements • Identify gaps • Focus R&D priorities
Collaborative Projects	• Eliminate gaps • Deliver learning & critical data • Leverage efforts & participants' resources
Forums & Workshops	• Share solutions & best practices • Prioritize key challenges • Network with customers & suppliers

What is iNEMI?

The International Electronics Manufacturing Initiative (iNEMI) is

- a not-for-profit,
- industry-led,
- highly efficient

R&D consortium of approximately 90 leading electronics manufacturers, suppliers, associations, government agencies and universities.

Electronics Manufacturing – Virtual Vertical

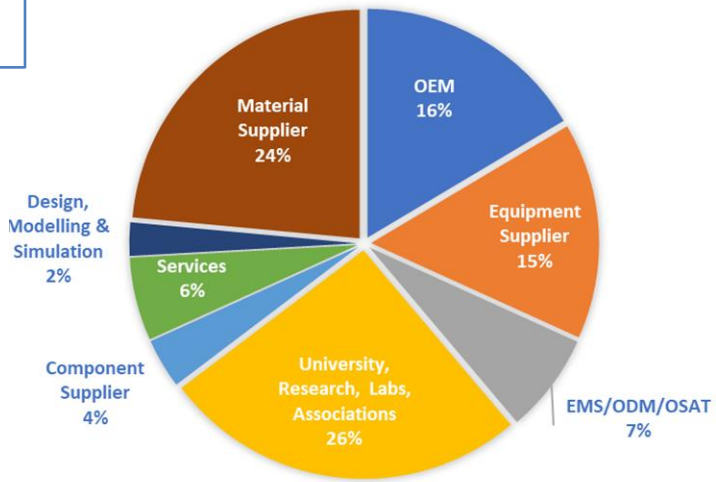
End – End Design / Supply Chain

Leaders & Experts

Global

Diversified

MEMBERSHIP DEMOGRAPHICS



iNEMI “Sprint” Project

- Time was critical. In fact, it may have already been too late to save some equipment.
- iNEMI initiated a Sprint project, with planned completion in a few weeks.
- A call to member companies went out. Several were eager to join. These included Amphenol, Celestica, Foresite, IBM, Intel, IPC, Keysight Technologies and Nokia.
- The experts on chemicals, corrosion and reliability from these companies met weekly to share knowledge, assign research, gather information, and draft and re-draft a guidance document.

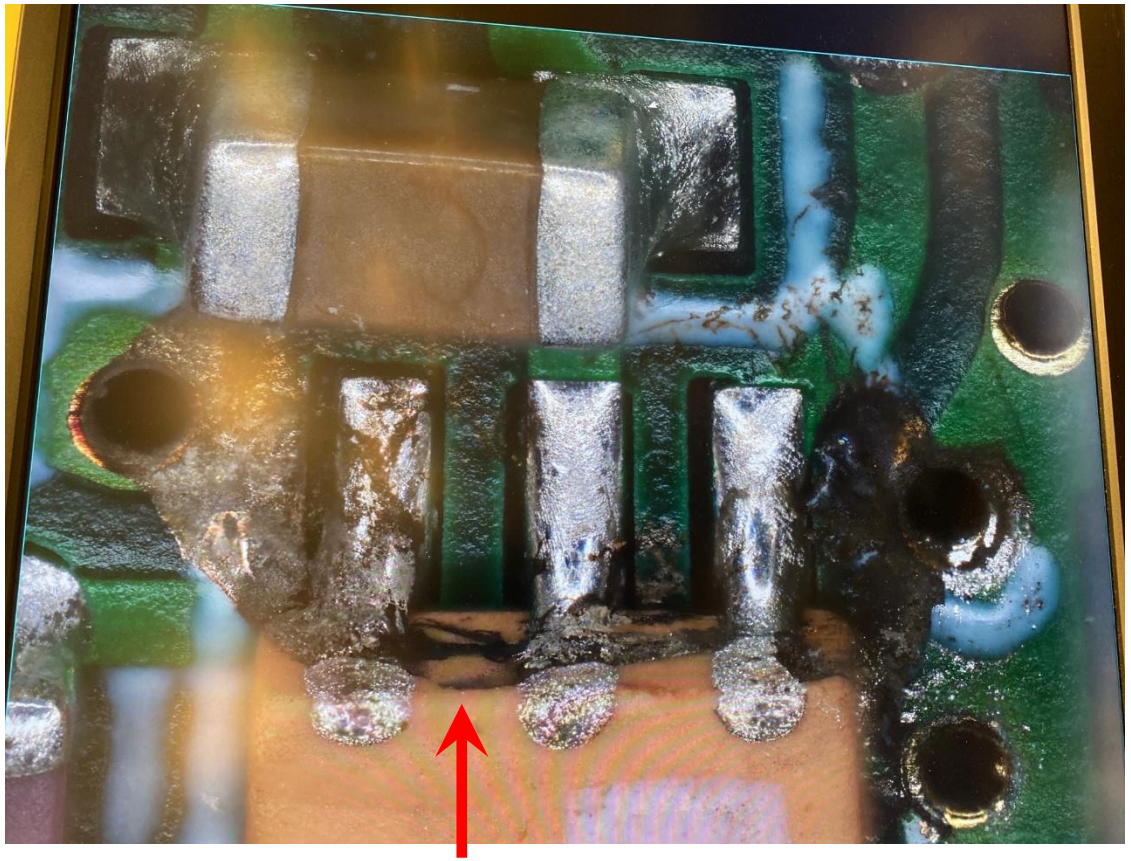
The Chemicals

- The United States Environmental Protection Agency (EPA) published List N, with chemicals by virus type efficacy, active ingredient, manufacturer and brand name.
- The team reviewed this list and rated the impact on electronics from low to high. Testing was not performed.
- Considerations:
  - Corrosion from direct contact with electronics
  - Corrosion from fumes entering products
  - Enhance pitting or atmospheric corrosion

Industry Experience

The various manufacturers had experiences to share:

- During the Anthrax threat in the early 2000's, the strong chemicals used to kill spores, and caused equipment to fail within a few months
- Cooling fans pulled in heavily polluted air and dust, resulting in failure within several months
- Failure analysis companies had already started seeing corrosion and dendrite formation between leads in disinfected products



Dendrite formed by voltage difference + active chemicals + moisture, which de-plates from one pin and deposits metal between pins, creating a short

Chemical Corrosiveness Considerations

- **Direct contact with electronics**
  - While even pure water can cause electronics to short when the product is powered on, there is higher risk with conductive or corrosive chemicals
  - Oxidizers can generate electrolytes and acids
- **Fumes entering products**
  - Halogenated chemicals generate fumes that can enter through product vents and corrode the metal circuitry
  - May enhance pitting or atmospheric corrosion, creating open circuits
  - Will reduce surface resistivity, eventually creating shorts or degrading product performance
  - May react with surfaces to create corrosive chemicals

Process Considerations

- **Most equipment has venting for cooling. Processes that allow chemicals to enter the "box" through these vents or other openings are a danger.**
  - Drops from cloths or sponges
  - Spraying, which has large droplets that can bridge liquid across conductors
  - Fogging, which has small droplets that can easily enter the product -- and when non-optimal can generate larger droplets

Conclusions from Consultation and Research

- Chemicals entering the product are likely to corrode electronics
- Liquid from spraying or fogging could enter the products
- Fumes from halogenated and other chemicals could enter products
- Over-wet wipes or sponges could allow liquid to enter the products.

Chemicals: Risk Assessment for Use on Electronics

Active Ingredient / Chemical Family	Impact on Electronics	Rationale
Alcohols, e.g., isopropyl alcohol (IPA), ethanol	Low	Low risk for corrosion at recommended concentrations.
Phenolic & Hexanediol	Medium	Risk of corrosion – Is a weak organic acid that can chemically bond to metal surfaces that could lead to a lower surface resistivity and could weakly attack insulators.
Amine /Ammonia	High	Risk of corrosion - Compounds will react with copper and remove its protective oxide.
Halogen	High	Risk of corrosion - Will enhance copper, aluminum, and stainless-steel corrosion. Pitting corrosion will be the most prevalent but can also initiate atmospheric corrosion.
Acids, e.g., citric acid, carboxylic acid	High	Risk of corrosion - Can lead to accelerated electrolyte formation and create various types of corrosion.
Acetates	High	Risk of corrosion - Will act as a catalyst on any legacy lead based electronic forming Lead Carbonate from CO_2 in air which then subsequently disintegrates.
Hydrogen Peroxide	Medium (Lower concentrations) High (Higher concentrations)	Risk of corrosion - Is an oxidizer and as concentrations increase and in the right environment may create an acid or electrolytes leading to various types of corrosion. Understanding concentration level and exposure time is important to risk assessment. If used, apply with appropriate caution.

Guidance and best practices, the short version

- **Use an alcohol-based cleaning solution**
  - Alcohol-based products were the only EPA-recommended chemical that had a low risk for electronics
- **Wipe with saturated but not dripping cloth**
  - Spraying and fogging would likely allow chemicals to enter the product

Download the document here:

Disinfecting Best Practices Request (inemi.org)
https://www.inemi.org/disinfecting-best-practices-request

Q & A

Thanks a lot for your time and attention!

Any questions and/or comments?

References

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