Evaluating the Material Compatibility of CaviWipes™ 2.0

Healthcare facilities face increasingly hard-to-kill and emerging pathogens that put patient and staff safety at risk. To meet this challenge, infection prevention specialists are tasked with identifying cleaning agents that offer the efficacy and fast kill-time to combat Healthcare-Associated Infections (HAIs) — including emerging pathogens — without contributing to the degradation, malfunction and failure of medical equipment, devices and surfaces. As such, healthcare facilities must prioritize the material compatibility of surface disinfectants used in today and tomorrow's healthcare environments.

Background

For more than 30 years, Metrex has been protecting patients and staff in a wide range of healthcare settings, with industry-leading infection prevention solutions used in thousands of healthcare facilities. Backed by extensive laboratory research, our proven products are designed to quickly and effectively clean and disinfect hard, non-porous surfaces in clinical environments.

Responding to changing customer needs and HAI challenges, we have continually evolved and advanced our products to provide faster contact times, stronger efficacy claims, ease of use, and excellent material compatibility for a broad spectrum of pathogens and surfaces.

The next-generation in surface disinfectant, CaviWipes 2.0 meets this checklist of must-have features for a fast-acting solution with evidence-backed efficacy claims — including qualification for the EPA's Emerging Viral Pathogens claim. Just as importantly, CaviWipes 2.0 also offers excellent material compatibility.

Selecting a Surface Disinfectant

As harder-to-kill pathogens continue to emerge, more effective infection prevention is paramount to patient safety. This includes developing a vigilant approach to disinfecting surfaces. The Centers for Disease Control and Prevention recommends using disinfectants that have the following properties[1] including but not limited to the following:

- *Broad antimicrobial spectrum*
- *Efficacy claims against 42 pathogens, including SARS-CoV-2*
- *Fast-acting efficacy with a rapid kill time*
- *Clear label with easy-to-follow information*
- *Good cleaning as well as disinfectant properties*
- *Surface or material compatibility to minimize degradation and failure*

While the benefits of contact time and efficacy are clear, the issue of material compatibility and its importance are worth a deeper dive.

Why Material Compatibility Matters

Consider the vast number and types of surfaces that require disinfecting in any given healthcare environment: acrylic, stainless steel, polycarbonate, polyethylene, nylon, polyphenylsulfone, polypropylene, ABS, and more. Each type of material has varying disinfection needs and challenges. Each type of material also has its own molecular composition that reacts differently to the surface disinfectant being used to clean it multiple times a day.

In fact, busy healthcare environments with rapid turnover need daily cleaning every 10 minutes.[2] With prolonged and repeated exposure to chemical disinfectants, the surfaces of medical equipment, devices and other assets can start to weaken and develop defects. With the added stress that comes from repeated usage, the damage can become even worse.

Certain materials react to certain disinfectants in different and complex ways. This interaction is at the core of material compatibility. Materials that degrade or show signs of damage after repeated and prolonged exposure to surface disinfectants are considered incompatible. Material incompatibility can lead to a host of problems including:

- *Malfunctioning devices and medical equipment*
- *Shorter working life and repair/replacement costs*
- *Interruptions to clinician workflows*
- *Impact on quality of patient care*
- *Lower patient and staff satisfaction*
- *Patient and staff safety risks*

As healthcare facilities turn to more powerful disinfectants to control HAIs and emerging viral pathogens, they also run a higher risk of material incompatibility that may result in costly defects, damage and failure.

Incompatibility In Action

The surface disinfectants you use to clean mattress covers, flooring and equipment may be incompatible with the materials those items are made from, causing degradation and failure. This puts your patients at risk. A degraded mattress cover can allow body fluids to seep into the mattress, for example. Cracked flooring can become a trip hazard and more difficult to clean and disinfect properly. Damaged medical equipment can hide dangerous pathogens inside cracks and fissures. As these problems persist and worsen over time, they become costly to correct, repair or replace.

Causes of Material Incompatibility

Multiple factors influence a surface disinfectant's level of compatibility with the device, equipment or surface material. These include:

- *The active ingredient in the disinfectant*
- *Type of surface the disinfectant comes into contact with*
- *How the device or equipment is designed and used*
- *Cleaning frequency and protocols*
- *Components found in the disinfectant, such as solvents, surfactants and additives*

Even materials that have a protective coating or paint — such as metal — can be vulnerable to damage and degradation from repeated exposure to disinfectants. Plastic materials are especially susceptible to incompatibility with surface disinfectants. Plastic failure is common in healthcare environments, and is concentrated around three types of failure.

Mechanical Failure: This occurs when a product is exposed to external forces greater than it can handle and deforms, cracks or breaks. Under repeated force or stress, the plastic will weaken over time until it fails.

Thermal Failure: Caused by exposure to extreme temperatures, thermal failure can result in swelling and warping under high heat, or cause materials to become brittle and vulnerable to cracking and shattering under cold temperatures.

Chemical Failure: Chemicals attacking a plastic can affect its strength, flexibility, appearance and weight, causing the plastic to soften, swell, or experience stress cracking. This in turn can make the plastic more vulnerable to failure.

Along with chemical failure — a direct chemical attack that causes molecular degradation — surfaces and materials can also be impacted by environmental stress cracking (ESC) caused by the presence of both chemicals and mechanical stress. In fact, studies show that ESC is one of the primary causes in around 25 percent of plastic part failure.[3]

What's in Your Disinfectant?

The typical disinfectant used in healthcare environments employs an active ingredient which kills the microbes; a solvent which solubilizes or dissolves components in the disinfectant; and other additives that play various roles. While the active ingredient in a disinfectant may have no effect on plastic, the amount, concentration, and final formulations of solvents and other additives can react and cause plastic to crack and degrade — ultimately resulting in failure or loss of function. The synergistic effects of these ingredients may also be important in determining the eventual compatibility.

Bottom line: It's important to pay close attention to the disinfectant's material compatibility claims and compatibility guides before you use it.

Defining & Passing the Material Compatibility Test

Yes, you absolutely want your surface disinfectant to have strong efficacy claims with the evidence to back them up. Those claims, however, are not worth the label they're printed on if the disinfectant you're using causes medical equipment, devices and surfaces to degrade, malfunction, fail and impact patient care.

Understanding the complexities of material compatibility requires extensive knowledge and training. As such, there's a growing body of research in the healthcare industry dedicated to material compatibility. To date, infection prevention professionals spend countless hours, resources and energy stocking and managing multiple types of cleaners and disinfectants — creating more complexity and burden for staff.

Powerful disinfectants are typically thought to have poor material compatibility; what makes them so strong, also makes them damaging to surfaces and materials. The question is: how do you create a surface disinfectant that offers broad efficacy claims to meet your diverse infection prevention needs, without degrading your surfaces, devices and medical equipment?

The answer: rigorous research, development and testing. Currently, no standardized method exists to determine the chemical compatibility of disinfectants with materials used in healthcare setting. Different organizations use vastly different methods to test and evaluate stress levels, time of exposure to chemicals, temperature and properties.

For chemical exposure, some manufacturers do wipe tests that involve a wait time while the chemicals air-dry between wipes while others do continuous exposure with no air-drying in between. For evaluation, some perform impact and tensile tests that subject the materials to controlled tension until failure, while others only do visual inspection. Whatever the testing method, it's important to choose a test method that best represents real-use case since different chemical exposure methods may result in different observations or trends.[4] It's also important to reduce as much human error as possible to ensure repeatability and reproducibility.

Metrex Internal Testing Methodology

Metrex has developed and implemented a comprehensive and standardized method for evaluating material compatibility for CaviWipes and CaviWipes 2.0. Beyond mere visual inspection, we have studied the effects of different active ingredients, solvents and additives on materials commonly found in healthcare settings. Below is an overview of Metrex's multi-pronged material compatibility test methodology.

Plastics Test Method

Metrex implemented an in-house comprehensive and standardized method to minimize variation and subjectivity. Tensile bars were placed under 0.91% strain and wiped either manually or using an automatic tool a total of thirty cycles with 11 minutes and 55 seconds of wait time between each wipe cycle to allow for air drying. Each wipe cycle consisted of one back-and-forth wiping. After 30 cycles, tensile bars were left on the test fixture overnight. The total time the tensile bars were on the test fixture was 24 hours. A separate control group was also subjected to the same amount of time under same strain, but not exposed to any chemical. All tensile bars were rinsed with DI water and dried overnight before mechanical testing.

Visual observations and tensile results are used to determine material compatibility. All sample exposures were done in Metrex lab, and mechanical tests were performed either internally by Metrex, at external test lab or at collaborator's lab.

Plastics Testing Rubric

Note: Tensile bars are intentionally subjected to high strain to induce and accelerate ESC failures, allowing for the entire test to be completed within 24 hours. Higher strain also allows us to observe relative differences under same test conditions.

★★★★★	≥95% strength retention, **no visual cracks**
★★★★	≥95% strength retention, **minor cracks**
★★★	≥80% strength retention but no yield, **some cracks**
★★	<80% strength retention but not broken, **deeper/more cracks**
★	**broken**

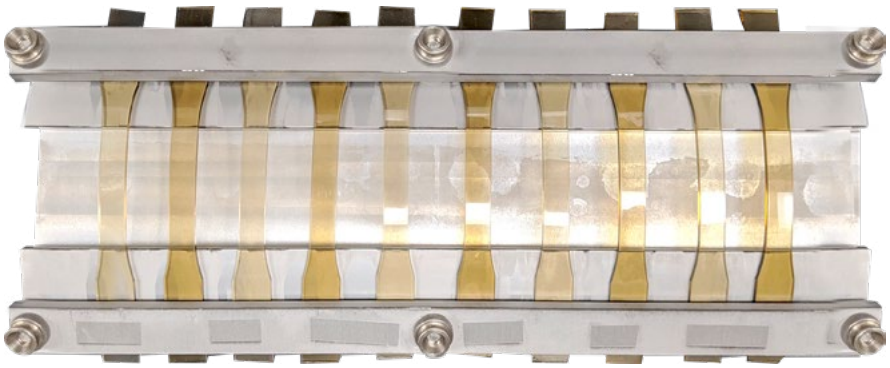

Fig. 1 Solvay Control tensile bar test with CaviWipes 2.0

Metals Test Method

Metal coupons were tested with CaviCide and CaviWipes 2.0 solutions. Tests were conducted at room temperature and included full and partial submersion of the coupons in the chemical. Visual and tactile evaluations were then performed. Interim inspection was done after seven days, and final inspection was done after 14 days. At seven days, the coupons were dried but not washed before inspection. After 14 days, coupons were washed with DI water and visually inspected.

Metals Test Rubric

★★★★★	Minimal change observed
★★★★	Minor discoloration or stains
★★★	Some discoloration, residue, corrosion and/or change in texture
★★	Severe discoloration, residue, corrosion and change in texture
★	Severe warping, loss of structure and or broken

Fabrics Test Method

Fabric was wiped with six minutes of air-drying time for a total of 100 times. Color measurements were done with spectrophotometer along with visual inspection.

Fabrics Testing Rubric

★★★★★	Minimal change in color ($\Delta E \leq 2$)
★★★★	Some stains spots and/or perceptible color change ($\Delta E \leq 3$)
★★★	Stains over 50% of area, perceptible color change ($\Delta E \leq 4$) and/ or change in texture
★★	Stains over 75% of area, perceptible color change ($\Delta E \leq 5$) and/ or change in texture
★	Severe loss of integrity

Overall Results

Compatibility results of CaviWipes 2.0 relative to CaviWipes, tested under the same conditions.

Material		CaviWipes™/CaviCide™	CaviWipes™ 2.0
Plastic[6]	ASA	★★★★★	★★★
	HDPE	★★★★★	★★★★★
	HPPA*	★★★★★	★★★★★
	LDPE	★★★★★	★★★★★
	Nylon 6,6	★★★★★	★★★★★
	PARA*	★★★★★	★★★★★
	PC	★★★★	★★★★
	PC/ABS	★★★	★★
	PC/PBT	★★★★★	★★★★
	PC/Siloxane	★★★★★	★★★★★
	PESU*	★★★★★	★★★★★
	PP	★★★★★	★★★★★
	PPA*	★★★★★	★★★★★
	PSU*	★★★★★	★★★★★
Metal	Stainless Steel 304	★★★★★	★★★★★
	Titanium Grade 2	★★★★	★★★★
Fabric	Nauga	★★★★★	★★★★★
	Ultraleather	★★★★★	★★★★★

** Samples were wiped manually for a total of 60 cycles with at least 6 minutes of air-drying time. Total time on the test fixture was approximately 60 hours.*

*** CaviWipes contains durable, nonwoven, nonabrasive wipes presaturated with CaviCide surface disinfectant cleaner.*

Note: all compatibility results were done in-house based on the criteria mentioned above. Results may vary depending on test methods. These are suggested guidelines only, and final evaluation should be performed directly by medical device manufacturers.

Solution

Given the enormous diversity of medical equipment, devices and surfaces found in healthcare environments, no single cleaner or process will be 100 percent compatible with 100 percent of materials. Metrex addresses this reality by continuing to expand its portfolio of surface disinfectant products to meet the widest range of possible needs. Metrex's latest generation of surface disinfectant, CaviWipes 2.0 leverages decades of research and rigorous testing protocols to offer excellent compatibility for a broad spectrum of hard, nonporous surfaces commonly found in healthcare settings.

The challenge of material compatibility and all its complexities will require not just a next-generation surface disinfectant but a collaborative solution. To that end, Metrex is actively partnering with Solvay, Covestro, and other component manufacturers, including polymer companies and medical device manufacturers, to support their compatibility testing and advance policies and processes that will improve material compatibility.

Metrex recognizes and applauds manufacturers' efforts to make material compatibility a central objective in the design of medical equipment and devices. This includes developing formulas and materials with demonstrated resistance and durability even when exposed to disinfecting solutions and chemicals.

Conclusion

By selecting a surface disinfectant that has been rigorously lab-tested to be compatible with the wide range of materials, infection preventionists can extend the working life of their devices, equipment and materials; lower costs related to repairs and replacements; and improve patient as well as staff safety and satisfaction.

Surface disinfectants are critical to the control of Healthcare Associated Infections (HAIs) in any healthcare environment. When selecting surface disinfectant solutions for use in their facilities, infection prevention professionals must consider an array of factors, including the product's efficacy claims, contact time and ease of use. Equally important to consider is the products' material compatibility.

The good news is: healthcare professionals do not have to compromise efficacy for material compatibility. The latest in infection prevention from industry leader Metrex, CaviWipes 2.0 is proven to be effective against 42 pathogens, and fully qualifies for the EPA's Emerging Viral Pathogens claim for all virus types (enveloped, large and small non-enveloped viruses) to meet current and potentially future infection prevention needs.[5] With a 2-minute contact time and easy-to-follow label, CaviWipes 2.0 kills pathogens quickly and efficiently. This strong disinfecting performance comes with excellent material compatibility with most hard, non-porous surfaces commonly found in healthcare settings.

With these combined features, healthcare professionals can rely on CaviWipes 2.0 for a wide range of infection prevention needs with confidence that their people, environments, and surfaces will be protected.

References

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2. Turner, E., Lybert, L., Lui, Y., Meehan T., "An Emerging Certification for Medical Device Cleanability", [PowerPoint Presentation], MD&M West, Anaheim Convention Center, Anaheim, CA, United States. February 12, 2020.

3. Jansen, J. A. "Environmental Stress Cracking - The Plastic Killer", Advanced Materials & Processes. June 2004.

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5. Guidance to Registrants: Process for Making Claims Againtst Emerging Viral Pathogens Not on EPA-Registered Disinfectant Labels, August 19, 2016. www.epa.gov/sites/production/files/2016-09/documents/emerging_viral_pathogen_program_guidance_final_8_19_16_001_0.pdf.

6. Plastic Acronyms:

   ASA: Acrylonitrile styrene acrylate

   HDPE: High Density Polyethylene

   HPPA: High Performance Polyamide

   LDPE: Low Density Polyethylene

   PARA: Polyarylamide

   PC: Polycarbonate

   ABS: Acrylonitrile-butadiene-styrene

   PBT: Polybutylene Terephthalate

   PESU: Polyethersulfone

   PP: Polypropylene

   PPA: Polyphthalamide

   PSU: Polysulfone

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