Metrex
INFECTION PREVENTION

covestro

Chemical Resistance Testing of Covestro Plastics with Metrex™ Surface Disinfectants

With a growing emphasis on proper cleaning and disinfecting to prevent healthcare-associated infections (HAIs), equipment and devices in healthcare settings are routinely exposed to chemical agents. Several types of chemical agents are available for surface disinfection, and their antimicrobial effects work through different mechanisms, such as disruption of bacterial cell wall and outer membranes or interfering with their metabolism. Healthcare workers face the challenge of choosing an appropriate product. In addition to efficacy claims, contact times, ease-of use, and target temperature range, professionals must also look closely at material compatibility of the disinfectants they are using to achieve an effective infection prevention strategy.

The surfaces of medical equipment are made of a variety of materials including metals and plastics. A common cause of premature failure in plastic is a phenomenon called environmental stress cracking (ESC). Some important factors affecting this failure mode include the plastic type, chemical agent, and amount and type of stress in the part. [1] Polycarbonate and polycarbonate blends are popular choices among medical

device manufacturers due to a combination of their stiffness, impact resistance, heat and flame resistance, color, ease of molding, and cost. [2] This document provides the results of chemical compatibility testing of selected Metrex surface disinfectants with polycarbonate-based materials from Covestro.

Metrex Products

Three products – CaviWipes™ 2.0, CaviWipes™ Bleach, and CaviCide™ (testing using saturated wipes) were used in this study. Table 1 shows the active ingredients in each formulation. As a reference, CaviCide™ (EPA Reg. No.: 46781-6) and CaviWipes™ Bleach (EPA Reg. No.: 46781-14) have contact times of 3 minutes, while CaviWipes™ 2.0 (EPA Reg. No.: 46781-17) has a contact time of 2 minutes.

Name	Active Ingredient
CaviCide™* (saturated into a wipe)	Quaternary Ammonium, <20% Alcohol
CaviWipes™ Bleach	Sodium Hypochlorite
CaviWipes™ 2.0	Quaternary Ammonium, <20% Alcohol

Table 1. Metrex surface disinfectants and corresponding details.

*This study is only intended for compatibility evaluation. Impregnating wipe substrates with CaviCide™ is to assess potential effects of the formulation on tested materials only for this study's purpose but is not in accordance with this product's use directions per its product label; users should follow the disinfectant manufacturer's Instruction for Use on the product label for proper usage

Covestro Products

Six Covestro materials were used in this test. Two of the materials, Makrolon® M6011 FR polycarbonate and Makroblend® M5005 FR PC+polyester will launch commercially in 2021 and were developed specifically to withstand strong chemical agents.

Name	Type	Description
Bayblend® M301 FR	PC+ABS	Flame retardant grade with high productivity
Makroblend® M4000 FR	PC+polyester	Skin-contact biocompatible, flame retardant PC blend with high chemical resistance for equipment housings
Makroblend® M5005 FR	PC+polyester	Skin-contact biocompatible, non-brominated flame retardant PC blend with high chemical resistance for equipment housings
Makrolon® 2458	PC	High productivity medical grade polycarbonate for various healthcare applications
Makrolon® 3158	PC	Medical grade polycarbonate for applications requiring high chemical resistance
Makrolon® M6011 FR	PC	Skin-contact biocompatible, flame retardant polycarbonate with high chemical resistance for equipment housings

Table 2. Type of Covestro polymers used in this study and brief description. PC: polycarbonate; ABS: acrylonitrile-butadiene-styrene.

Test Method and Criteria

ASTM D638 Type I tensile bars were put under 0.91% flexural strain, and the gauge (middle) portion was wiped with disinfectant products for a total of 30 cycles. Each cycle consisted of one back-and-forth wipe motion. There was 11 min 55 sec of waiting time in between each wipe cycle to allow for air-drying.

For CaviCide™, wiping was done using an automated wiper. CaviCide™ was dispensed onto a wipe substrate prior to the start of every cycle. The wipe substrate was the same one used for CaviWipes™. For CaviWipes™ 2.0 and CaviWipes™ Bleach, manual wiping was used according to the same procedure, because CaviWipes™ 2.0 and CaviWipes™ Bleach are not available in liquid form.

After the 30 wipe cycles, the tensile bars were left in the test fixture overnight for a total of 24 hours. A separate control group was also subjected to 24 hours under the same strain but not exposed to any chemical. Each plastic / disinfectant combination had 4 repeats. All tensile bars were then rinsed with DI water and dried overnight. Bars were conditioned for a minimum of 40 hours and tensile testing was performed according to ASTM D638. Visual observations and tensile strength results were used to determine compatibility. Chemical exposure was performed in-house by Metrex and tensile tests were performed in-house by Covestro.

The materials in Table 2 have similar modulus, thus the bent strip test is an appropriate method for an initial comparison of their chemical resistance. A tensile bar under 0.91% flexural strain will result in approximately 20 MPa of maximum loading stress (exact values vary depending on modulus). The strain is intentionally chosen to be high to induce and accelerate ESC failures, allowing for the entire test to be completed within 24 hours. This also reduces the effects of stress relaxation. Stress relaxation occurs in thermoplastics due to rearrangement of molecular chains, causing the observed stress in the material to decrease over time. [3] Comparing materials with different stress relaxation rates under continuous strain for a longer period may give misleading observations due to greater deviation in their stresses.

Criteria for ratings are as defined below:

★★★★★	≥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

As a reference, the image below roughly depicts how the cracks observed visually correspond to the tensile strength retention. Note that these images do not fully cover all possible scenarios and are intended only for reference purposes.

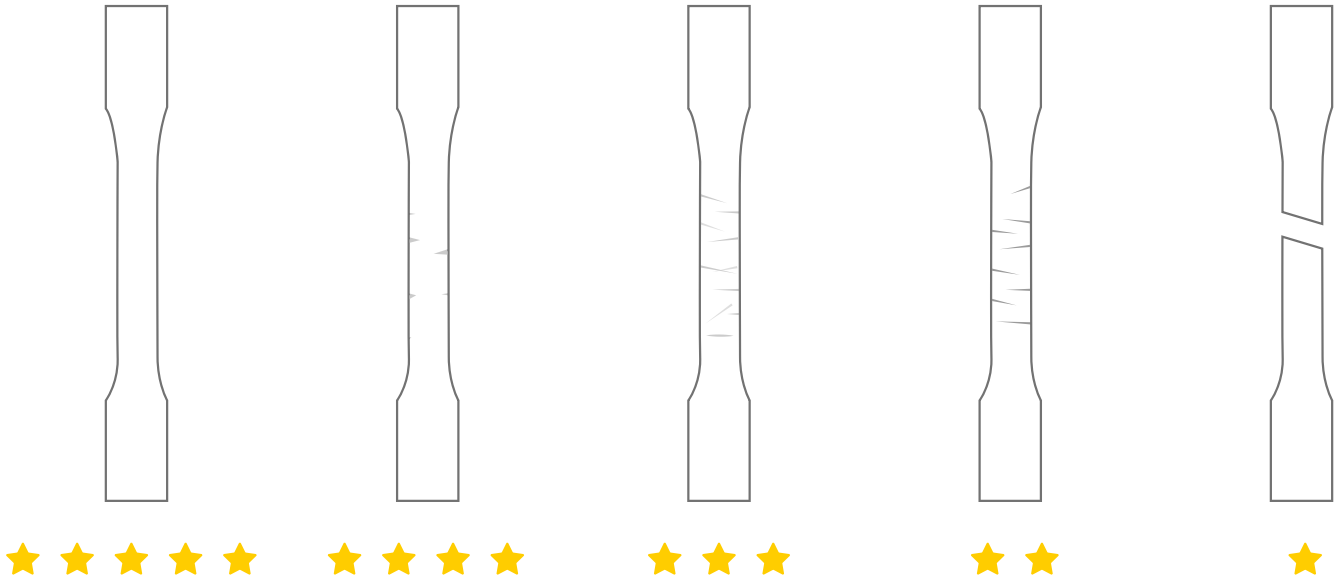

Figure 1. Visual depiction of cracks corresponding to ratings

Results and Discussion

Table 3 summarizes the results of this study. CaviWipes™ Bleach showed excellent compatibility with all tested materials. Three Covestro materials developed for chemically resistant housings Makrolon® M6011 FR polycarbonate, Makroblend® M4000 FT PC+Polyester and Makroblend® M5005 FR PC+Polyester – each flame-retardant material with skin contact biocompatibility - showed relatively good compatibility with the chemical agents tested.

	Wipe saturated with CaviCide™	CaviWipes™ Bleach	CaviWipes™ 2.0
Bayblend® M301 FR	★ ★ ★	★ ★ ★ ★ ★	★ ★
Makroblend® M4000 FR	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★
Makroblend® M5005 FR	★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★
Makrolon® 2458	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★
Makrolon® 3158	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★
Makrolon® M6011 FR	★ ★ ★ ★ ★	★ ★ ★ ★ ★	★ ★ ★ ★ ★

Table 3. Results of Metrex disinfectants with various Covestro polycarbonate-based plastics.

Among the plastics tested, Bayblend® M301 FR, a high-flow flame-retardant PC+ABS blend, was most susceptible, while the Makroblend® PC+polyester alloys showed better resistance. The two standard polycarbonate materials, Makrolon® 2458 and Makrolon® 3158, illustrate how molecular weight of a polymer affects the chemical resistance, which has also been noted elsewhere [1]. Makrolon® 2458 has a high melt volume-flow rate of 19 cm3/10 min, while Makrolon® 3158 has a lower melt volume-flow rate of 6 cm3/10 min [4] corresponding to its higher molecular weight, and Makrolon® 3158 showed better chemical resistance to CaviWipes™ 2.0 in this study.

Conclusion

Six polycarbonate-based polymers were tested against three Metrex surface disinfectants to assess chemical compatibility. The study suggests that Metrex surface disinfectants have relatively good compatibility with several polycarbonate-based materials recommended for medical device applications. This study depicts one method of comparing chemical compatibilities between different chemicals and plastics. If test conditions differ, for example if the tensile bars are exposed to lower stresses, the results may be different. Evaluation using medical devices with exposure conditions based on actual use cases should be performed to determine real-world compatibility.

References

[1] Robeson, L. M. (2012). Environmental stress cracking: A review. Polymer Engineering & Science, 53(3), 453-467. doi:10.1002/pen.23284

[2] Nowatzki, P.J. (2020). "Chemical Resistance Testing of Polycarbonates and Blends with Hospital Disinfectants and Cleaners", Proceedings SPE ANTEC 2020.

[3] Yeager, M. (2018). "Accounting for differences in modulus and stress relaxation behavior in plastics undergoing chemical resistance testing", Proceedings SPE ANTEC 2018.

[4] "Product Finder". Covestro Solution Center. Website: www.solutions.covestro.com/en/products/?query=Makrolon:relevanceName:countries:US&pageSize=40. Accessed: November 5th, 2020.

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