Inhibiting Microbes with

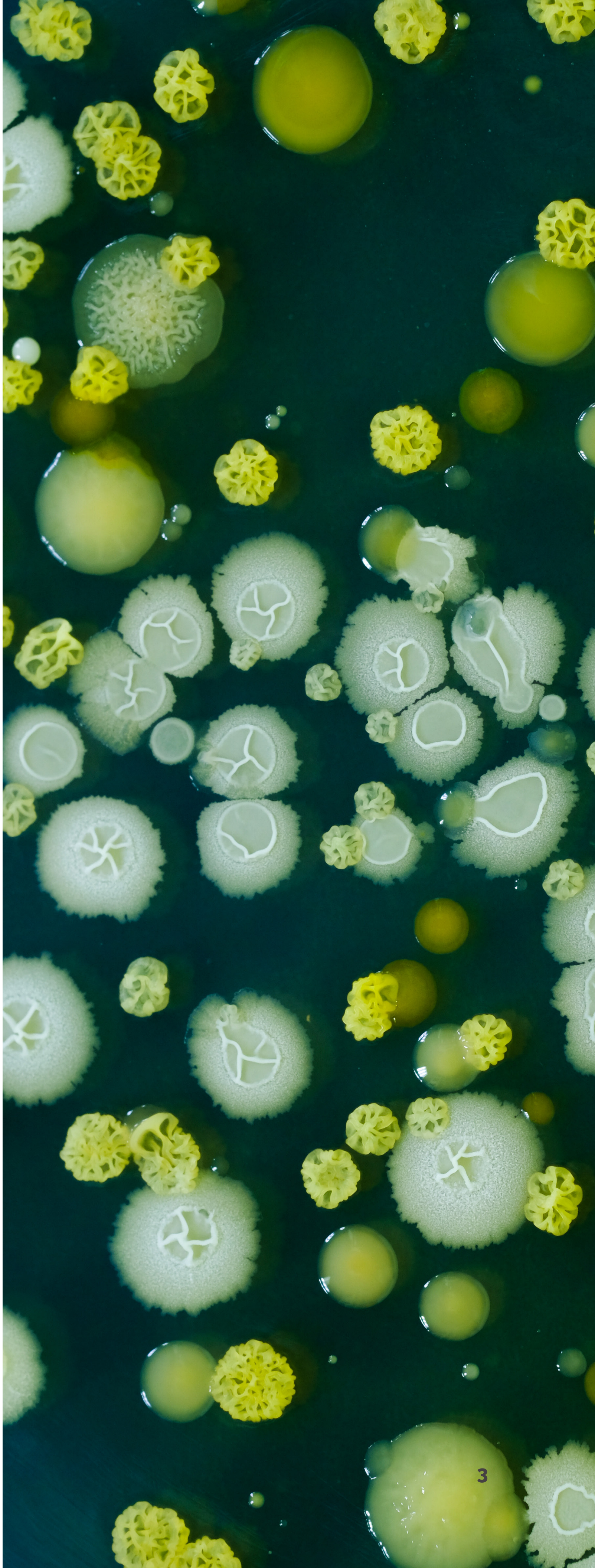
Topcoat Technology

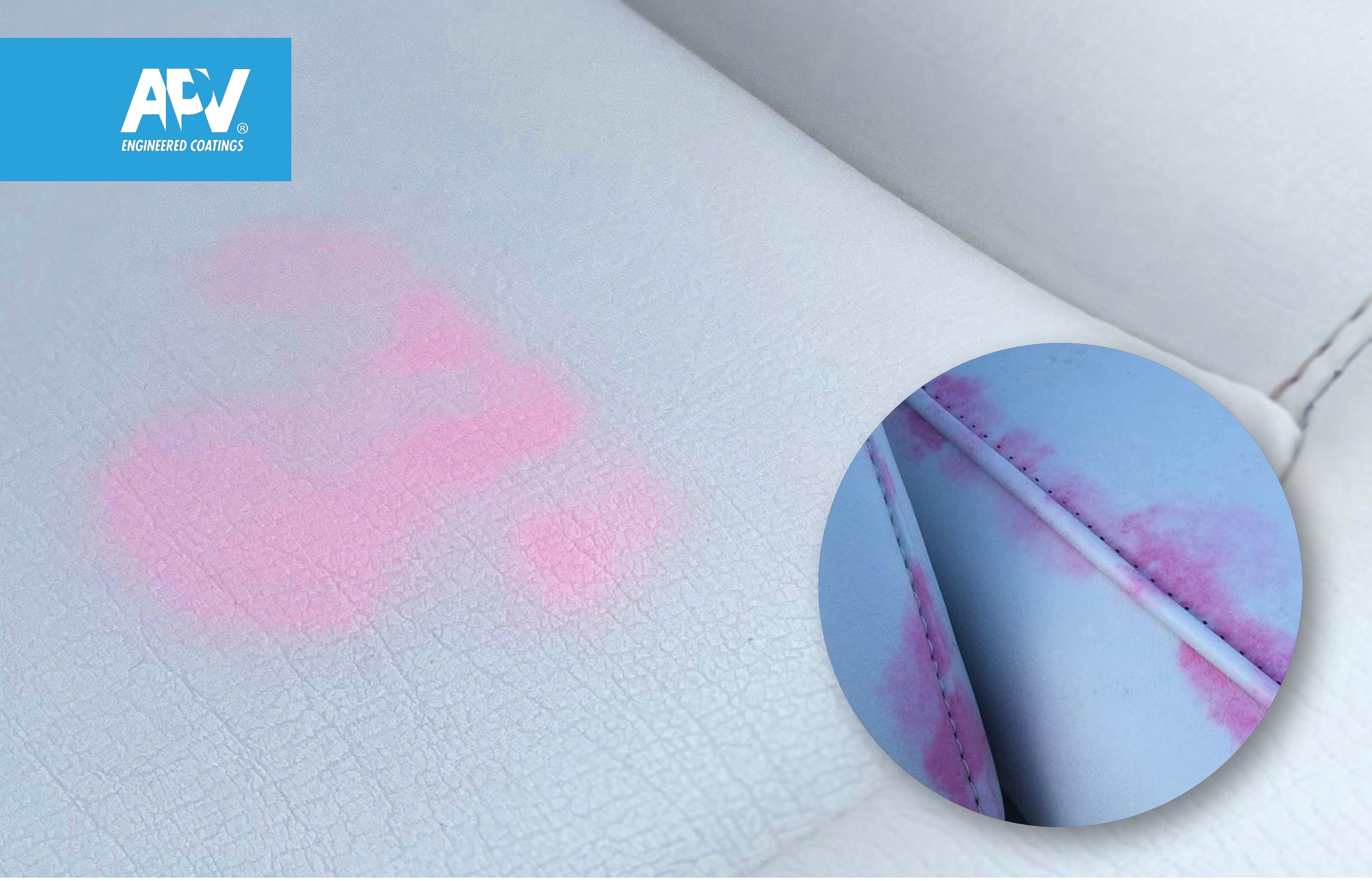
APV®
ENGINEERED COATINGS

TABLE OF CONTENTS:

When compounded performance additives in vinyl aren't enough, antimicrobial lacquers and topcoats offer extra protection.

Microbes, such as bacteria and fungi, can live on a surface for months. Manufacturers of flexible vinyl, films, fabrics, and textiles use engineered antimicrobial (AM) lacquers and barrier topcoats to offer an extra level of protection against harmful microbes, even when they have incorporated AM additives or biocides into the vinyl formulation during the compounding process.





A liquid AM finish applied to a fabric or flexible vinyl provides a bacteria-fighting layer directly on the surface and blocks the migration of the additives in the vinyl, a food source for microbe growth, over time. Topcoats, finishes and lacquers also protect against environmental stresses such as UV exposure, abrasion, oxidation, and biodeterioration of the substrate.

A liquid AM finish applied to a fabric or flexible vinyl provides a bacteria-fighting layer directly on the surface.

The seats on the luxury yacht shown above are damaged from mold and pink stain bacteria, a typical problem for marine and other outdoor fabrics. Pink staining bacteria produce a red liquid that diffuses into vinyl, creating a stain that cannot be cleaned. Antimicrobial topcoats can help to prevent such damage.

AM topcoats are especially effective for manufacturers of wallcoverings, upholstery, thermoformable polyvinyl chloride (PVC) laminates, mass transit seating and a range of other applications in health care, marine, hospitality and public and commercial facility settings anywhere high humidity and/or microbial contamination are significant problems.

Producing flexible vinyl

Flexible vinyl is made by mixing powdered PVC in a liquid plasticizer to produce a plastisol. Additional ingredients such as fillers, pigments, flame retardants, smoke suppressants and heat stabilizers are then mixed with the liquid plastisol to impart desired features. The plastisol is cast on release paper, passes through an oven at about 320 degrees (F), and then is cooled to form the flexible vinyl film. Next, cooled flexible vinyl film is either stripped of the release paper and used as-is or coated to improve its properties and performance.

Plasticizer migration

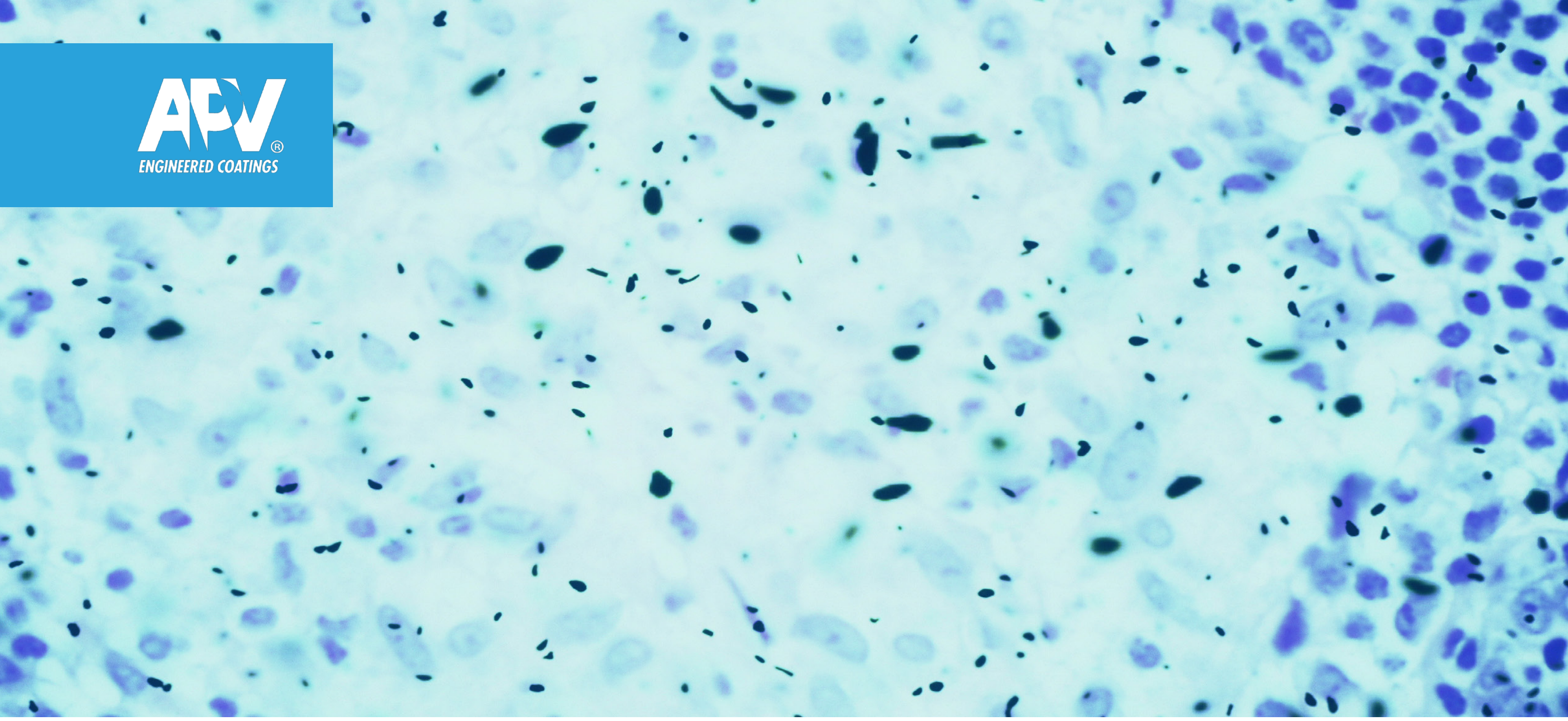
> Diffusion or migration of the plasticizer directly correlates to the performance and aesthetic of the vinyl fabric.

Flexible vinyl is subjected to a phenomenon called plasticizer migration, in which liquid plasticizer is slowly squeezed out of the material over time due to pressure applied by inter-molecular attractive forces between PVC molecules. Those attractive forces (cohesive energy density) cause other ingredients with lower energy than PVC to be released as well. As the plasticizer evaporates, creating the familiar "new car smell," the flexible vinyl loses flexibility and eventually begins cracking.

Diffusion or migration of the plasticizer directly correlates to the performance and aesthetic of the vinyl fabric. This migration also affects the performance of traditional lacquers, as the plasticizer diffuses into the protective coating, opening a pathway for stains and microbial growth to infiltrate the vinyl substrate.

Microbial contamination on flexible vinyl surfaces

Fungi and bacteria feed on phthalate ester-based plasticizers in flexible vinyl, thus accelerating the plasticizer migration as it passes from a higher concentration within the vinyl to a lower concentration



on the surface. This biological activity on the surface of flexible vinyl causes both physical and cosmetic damage.

Physical damage results when the loss of plasticizers change the flexibility of the vinyl to a brittle surface prone to cracking. Cosmetic damage occurs when bacteria use their secondary metabolism to produce chemicals designed to defend themselves against other organisms. Those chemicals diffuse into the flexible vinyl product, causing stains and unpleasant odors.

Pink stain bacteria (Streptoverticillium reticulum) is a perfect example and widely prevalent. It produces a secondary metabolite called prodigiosin, a red liquid that diffuses into flexible vinyl, creating pink stains that cannot be cleaned. Pink staining is a typical problem on boat seats; outdoor fabrics such as pillows, umbrellas and sun shades; and vinyl flooring used around pool and boat decks.

There is no conventional way to remove the stain because the visible pink dye created by the bacteria's metabolic processes is absorbed into the vinyl substrate and is no longer on the surface. It essentially diffuses into the vinyl in the same way the plasticizer migrates out of the vinyl. Prevention of pink staining can only be accomplished with barrier coatings, biocides or both to prevent the bacteria from blooming on the vinyl, which is why original equipment manufacturers (OEMs) are seeking out antimicrobial solutions.

> Prevention of pink staining can only be accomplished with barrier coatings, biocides or both.

Topcoat barriers

Some vinyl manufacturers incorporate biocides and fungicides into the plastisol formulation during the compounding process before it's cast on paper, extruded or calendared. This offers great initial protection against microbes. Like plasticizers, these additives are prone to migration, ultimately losing their ability to inhibit microbe growth within a year or two of outdoor exposure, depending on conditions.

Antimicrobial topcoats provide an extra layer of protection against the elements and block this diffusion process. Having antimicrobial protection in a concentrated finish on the surface is critical, as this is the primary point of contact for bacteria, fungi, UV rays, humidity and moisture.

Because AM additives can be expensive to incorporate into the vinyl formulation at an effective concentration, AM topcoats have become an alternative solution to the problem.

Antimicrobial additives

AM agents work by either inhibiting the organic cell from reproducing or reacting with the organic cell, essentially destroying it. More specifically, they damage cell walls, extracting the DNA, which upsets reproduction and kills the cell. Some AM additives also work by damaging the cell's flagella and pili, which interferes with the organism's ability to move and attach itself to a host surface.

Antimicrobial topcoats

Because AM additives can be expensive to incorporate into the vinyl formulation at an effective concentration, AM topcoats have become an alternative solution to the problem. For materials where bacterial and fungal growth is a significant nuisance, manufacturers often incorporate both AM additives and topcoats for the ultimate protection and life cycle. As mentioned, finishes offer a highly concentrated and thin bacteria-fighting layer directly on the surface of the vinyl or fabric.

The surface layer concentration is important because it is the area subjected to direct skin contact, such as human hands. Think about the contamination on the surface of medical bedding and mass transit seating.

Determining the right antimicrobial topcoat

When researching the appropriate AM topcoat for a flexible vinyl product, OEMs should identify the following:

Broad spectrum activity.

An effective concentration of the antimicrobial is essential, but it is also important to identify which types of microbes the coating must withstand. For flexible vinyl and fabrics, a broad spectrum of protection is essential. The coating manufacturer should conduct a variety of ASTM tests on the specific substrate with prototype coatings containing a range of AM concentrations, then provide data regarding microbe growth and the zone of inhibition.

Service life.

In studying the data from ASTM test standards and OEM-specified tests, positive initial readings are ideal, but learning how long the antimicrobial is effective is key. Coating manufacturers can conduct accelerated weathering testing on the coated material. Testing the coated prototypes in the real world, such as outdoor weathering, in comparison to the lab work will provide the performance information needed to determine effectiveness.

For example, marine upholstery manufacturers use ASTM E1428 Standard Test Method for Evaluating Performance of Antimicrobials in or on Polymeric Solids Against Staining by Streptomyce species (A Pink Stain Organism). After learning the optimum concentration of AM in the coating on the substrate via this ASTM test, installing a sample substrate in a harsh marine environment for several years would be an ideal way to determine the actual effectiveness of the AM finish.

Thermostability.

The topcoat should be thermally stable to withstand high processing temperatures during curing, embossing and laminating. The product's in-use temperature exposure is also important, especially on dark-toned products for exterior use, which endure greater thermal stress than lighter-hued products under UV rays.

Adhesion and flexibility.

The topcoat, whether water or solvent based, should be tested across various substrate types to determine if it has good adhesion to the surface and provides the necessary flexibility. Coating manufacturers run tests such as D2097 Flex Testing of Finish on Upholstery Leather, commonly known as W-flex, to determine adhesion and flexibility after specified cycles.

Regulatory compliance.

There is some controversy and strict regulations around types of AM additives used in the industry in terms of hazards and safety for direct-to-skin contact. Requirements should be specified to the coating manufacturer in advance to ensure compliance and safe products.

End user needs.

Vinyl manufacturers may have additional performance requirements that topcoats or lacquers can provide. Soft haptics or hand-feel, gloss, ability to be embossed, stain and chemical resistance, cleanability and abrasion resistance are examples of performance properties that coatings can provide.

Conclusion

Microbial growth has always been a challenge for the vinyl manufacturing industry due to plasticizer migration and diffusion of liquids into flexible vinyl. New developments in antimicrobial topcoat technology and effectiveness, bearing in mind environmental compliance, have affected the industry in a big way. With innovations in topcoats, finishes and lacquer formulations, OEMs are finding sustainable solutions to the needs of the industry and performance benefits that can offer distinct marketing advantages.

Contact APV Engineered Coatings today to discuss your antimicrobial topcoat needs.