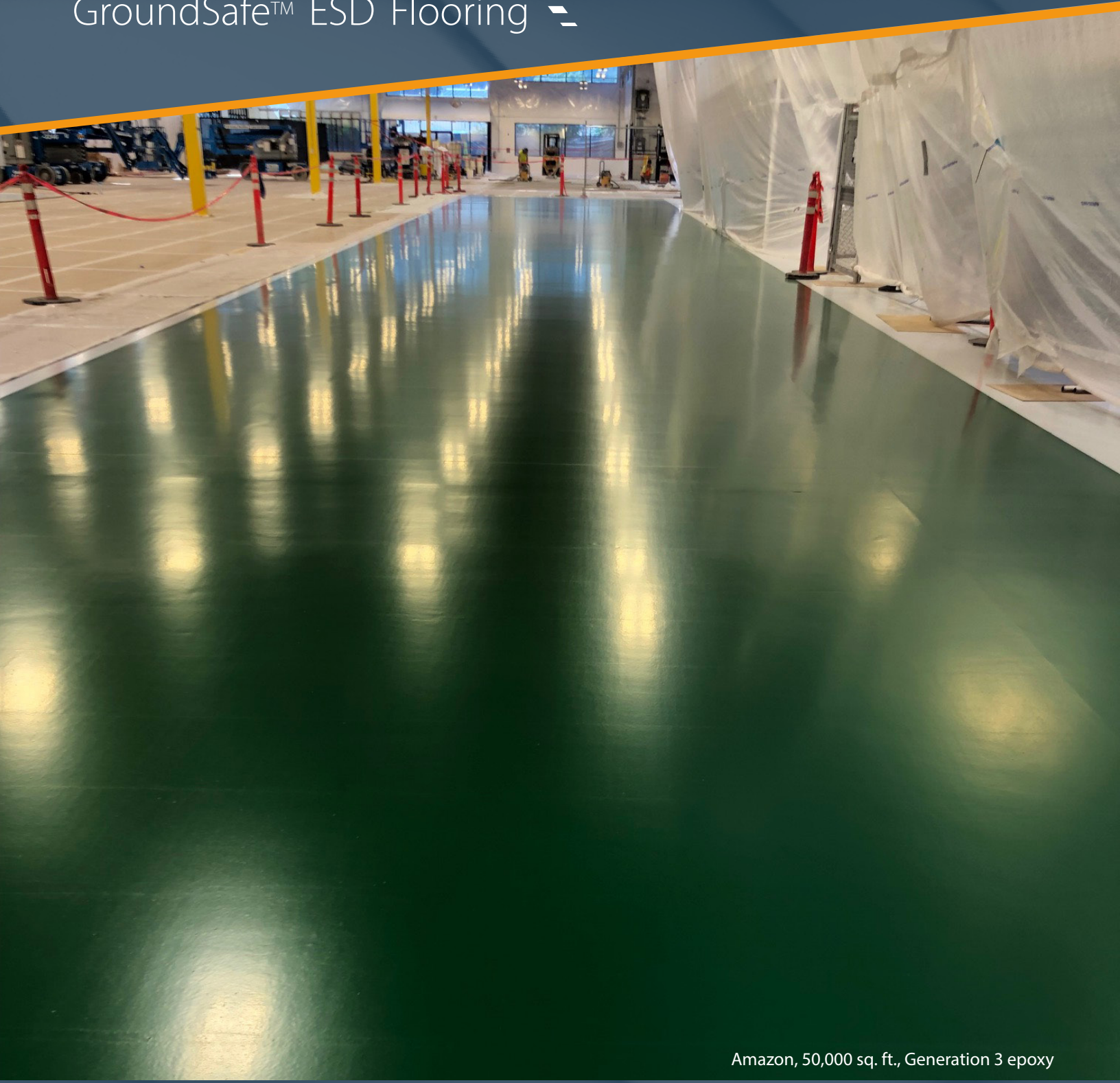
staticWorx®
GroundSafe™ ESD Flooring



Amazon, 50,000 sq. ft., Generation 3 epoxy

GroundWorx™ Epoxy

Value-engineered ESD epoxy

Many conductive epoxy coatings fail ESD body voltage tests. Gen 3 epoxies use nanotechnology for an attractive floor, in any color, that meets all ESD standards.

"Epoxy floor" is a generic term for a floor coating system. There are different ways to produce these coatings and technologies have changed over the years. Early—Generation 1—epoxy coatings consisted of resins loaded with high concentrations of carbon or graphite, and came only in black. These coatings performed well in ESD tests, but were unattractive.

Generation 2 coatings consist of an insulative primer, conductive ground plane, and shiny top coat with some conductive fibers. Generation 2 epoxies look great and come in a variety of colors but do not always pass body voltage tests required by ANSI S20.20. Manufactured on the job, these floors are difficult to install with a high risk of flooring failures.

Generation 3 coatings consist of an insulative primer and glossy, fully conductive, colorized top coat. Nanotechnology permits full infusion of conductive particles, for an attractive system that passes all ESD tests.

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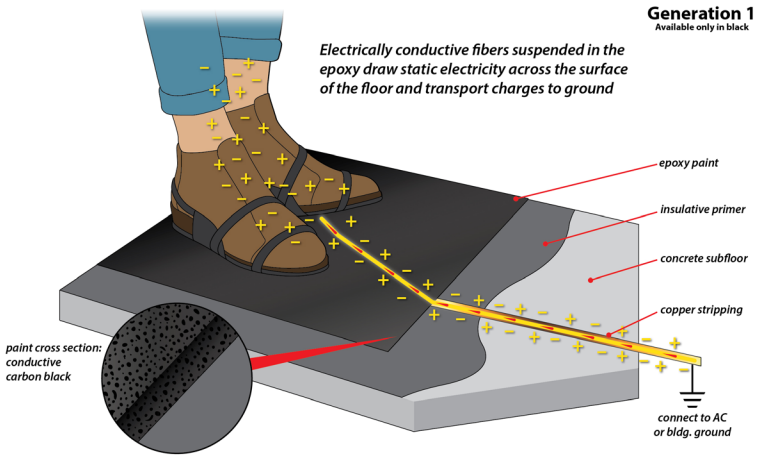
Why Some Epoxy Coatings Measure Conductive & Still Generate Body Voltage

GENERATION 1 COATINGS

In the industrial world, the phrase "epoxy floor" is often used when some kind of Part A and Part B polymer - or resinous - floor coating system is mentioned. Resinous floor coatings encompass a number of different polymer technologies, including but not limited to epoxies, urethanes, polyaspartics, methyl methacrylates (MMA), and vinyl esters. In generic conversation all of these materials get lumped together under the heading "epoxy floor."



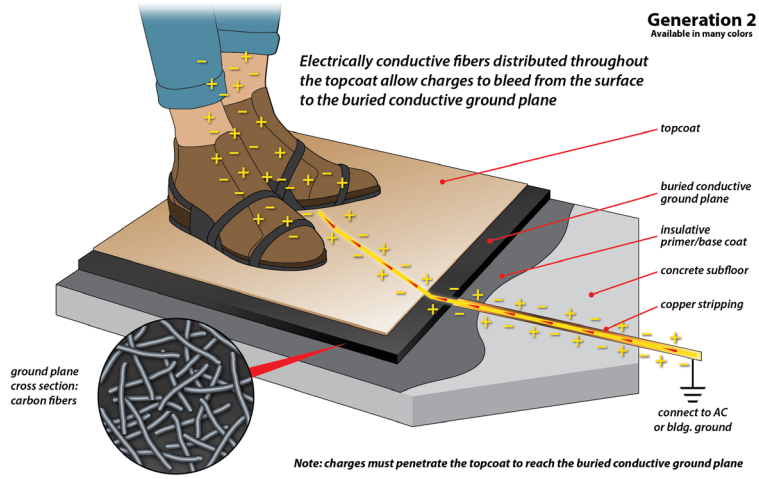
Over the years, epoxy floors for ESD control have evolved significantly in both performance, durability and aesthetics. The first ESD coatings (Generation 1) were resins loaded with high concentrations of carbon or graphite. Just like the first Ford cars, you could have any color floor - as long as you liked black.

These floors performed extremely well in static-control performance tests. However, carbon-colored Generation 1 floors were viewed unfavorably due to their appearance. These floors were usually installed in munitions and explosives handling applications.

GENERATION 2 COATINGS

Designers of the next generation (Generation 2) ESD coatings addressed the need for color options by introducing a multi-layer installation process whereby a semi-conductive top coat was installed over a much more conductive middle layer ground plane.

Generation 2 technology relied on the concept of path of least resistance by utilizing two parallel conductors. As with Generation 1 technology, the black primer layer was overloaded with carbon black or graphite. To address the need for color options, the top layer was produced with less carbon or less fiber, allowing colorization. Essentially, just enough conductive additive is/was used to provide a leakage path from the top layer into the buried ground plane below. This enabled the opportunity to build floors that came in a full array of color options.



Designed and installed properly, Generation 2 floors provide electrical resistive properties in both the conductive and static-dissipative range. Generation 2 technology was the prevailing technology for at least 25 years. This technology, however, contains a hidden pitfall.

THE ARRIVAL OF ANSI/ESD S20.20-2014

Until 2014, ESD flooring qualification and compliance audits consisted of simple resistance testing using a megohm meter. These resistance tests were performed using test method ANSI/ESD S7.1. As long as the floor measured below 1 billion ohms (10^9) and the aggregate resistance (per ANSI/ESD 97.1) of the **Person + ESD footwear + ESD Floor = < 3.5 x 10^7** the floor was considered ANSI compliant and the personnel grounding met all pertinent ESD standards requirements.

Most of the time, Generation 2 epoxy floors usually passed S7.1 and S97.2 tests, but not always. Forensics usually determined that the cause of an epoxy failing to meet 7.1 and 97.2 testing was either uneven distribution of conductive particles in the top coat and or inconsistent thickness of the top coat. In some failures the root cause was determined to be the result of a reapplication of the top coat over previously applied top coat. Too much thickness prevents electrical current from reaching through the top coat into the highly conductive buried ground plane.

These problems revealed a previously undiscovered greater cause for concern: Buried layer ground-plane floors generate unacceptable static charges on people despite appearing to provide adequate conductivity. This problem is called *tribocharging*.

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The main focus of ANSI/ESD S20.20 is to design an ESD program that prevents body voltage generation above 100 volts in the ESD-protected area. To expose body voltage generation aka tribocharging problems, the ESD Association added new requirements for the qualification phase of selecting ESD flooring. The changes were driven by the need to address body voltage on a person wearing ESD-controlled footwear.

See the test here: https://www.youtube.com/watch?v=vZaiqlKgbPI

CONDUCTIVE FLOORS MAY STILL GENERATE STATIC

In the years leading up to the 2014 revision of ANSI/ESD S20.20-2014, ESD auditors had encountered numerous flooring installations where the flooring measured in the conductive range and yet it did not limit static charges on people below the ANSI 100-volt limit. In the majority of lab tests, Generation 2 epoxy floors allowed charges of 300 to 700 volts on people walking while wearing properly functioning heel straps.

The new version of S20.20 requires qualifying a floor in a test lab at 12% relative humidity (ANSI/ESD S97.2) and proving that the floor will not allow a charge over 100 volts on any person wearing the exact footwear that will be used in the facility. Due to the semi-conductive top coat, Generation 2 epoxy floors do not address this requirement adequately. In most cases they fail, in part due to lack of surface conductivity.

WHY CAN A CONDUCTIVE EPOXY FLOOR FAIL A WALKING BODY VOLTAGE TEST?

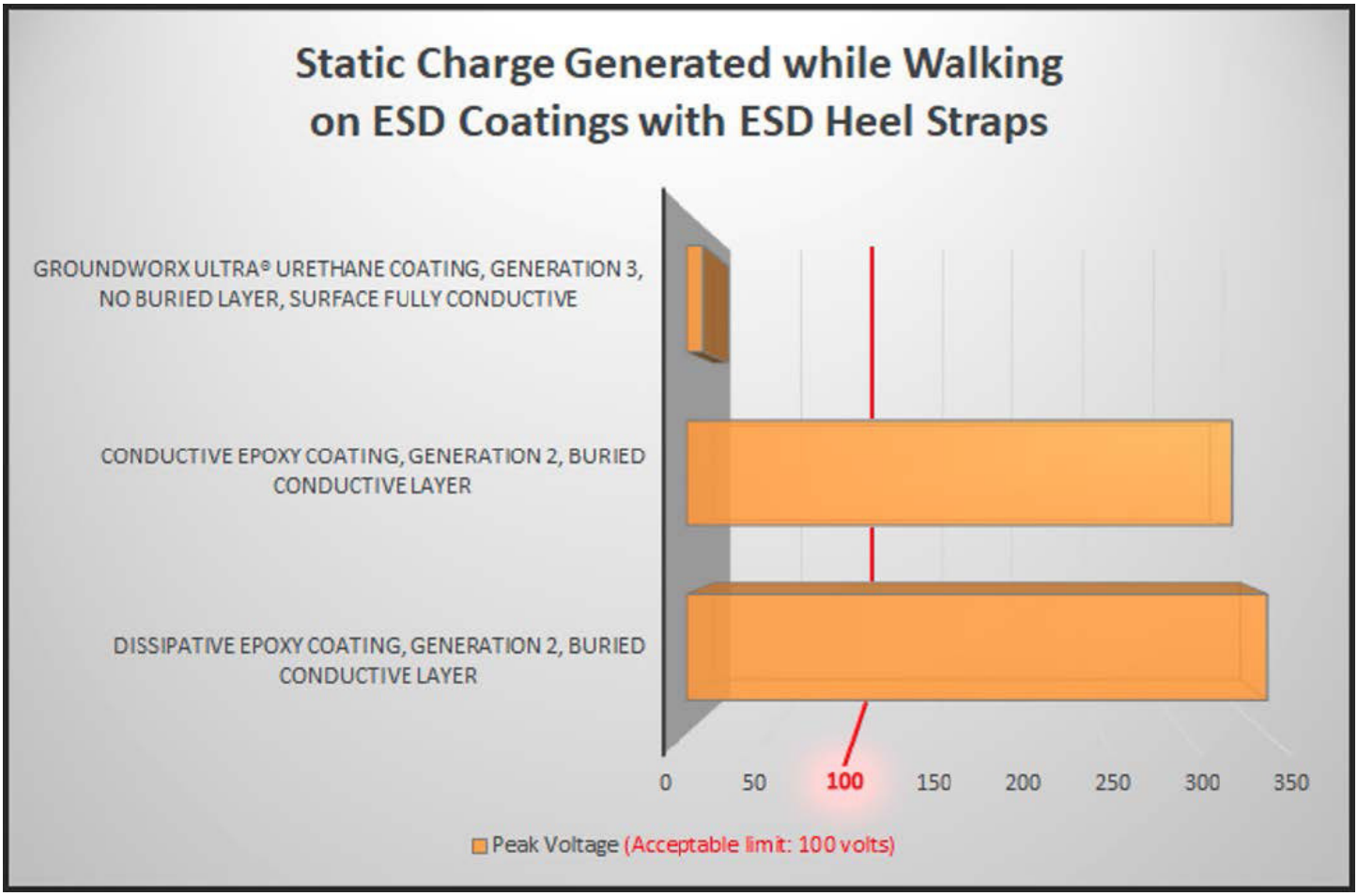
GENERATION 2 EPOXY AND 97.2 BODY-VOLTAGE TESTING

There are multiple reasons why Generation 2 epoxies don't fare well in 97.2 body-voltage tests. The most basic explanation is that these designs utilize top coats that are comprised almost entirely of standard, high-static-generating resins. There is just enough conductivity in these top coats to leak the charge to the buried, highly conductive ground plane, but an inadequate amount of conductivity to minimize charge generation.

Given that the highest percentage of the top coat is made of standard, static-generating epoxy, the

Generation 2 top coat is the weak link in the chain. If this were not the case, these systems would not require the application of a buried ground plane. This translates to a scenario where a person is actually walking on a material that either strips or offers up electrons to their shoe sole as their feet contact and separate from the top coat.

The result: significant tribocharging.



VARIABLES RAISE THE RISK OF PRODUCT AND SYSTEM FAILURES

As previously discussed, Generation 2 floors were initially designed to address the market desire for light color options. Since this desire was addressed by isolating (hiding) the most conductive element in the system, the solution added variables – i.e., a less conductive layer on top that required field application at a precise thickness.

Both layers were unnecessary for actual electrical performance and the process created a quality control dilemma on every Gen 2 job site. Because the conductive top layer required field application, the job site became not only the location where the floor was to be installed; it also became the materials manufacturing site of the floor (adding yet more variables).

It is extremely difficult to precisely control the exact thickness of a top coat when you're installing in large, acre-plus sized facilities with changing environmental conditions and varying concrete textures on every job. The only way to cope with these real-world incompatible variables was to expect perfect design, perfect execution, and a lot of luck.

There are numerous examples in design history of product and system failures due to poorly envisioned statistical possibilities when too many variables are present in the same product.

OTHER FACTORS AND GENERATION 2 CONSIDERATIONS

1. Whenever a black ground plane is installed below a lighter colored top coat, there will be areas where the top coat will not mask the ground plane. A common problem with Generation 2 floors is carbon black protrusion through the top coat. This blemishing problem can be remedied after the installation is complete and fully cured. It requires what amounts to a manicure of all spots where the color is inconsistent.

2. The presence of a black layer directly under a thin light coating makes the floor aesthetically vulnerable to damage from traffic and material handling. Scratches and impact damage expose the black layer creating an unsightly looking coating. (See figures 1 and 2 to the right.)

3. The thickness of the applied top coat must be carefully controlled. If it is applied too thickly, the floor will lack the proper conductivity. This is a tremendous amount of responsibility to place on a coatings applicator given the fact that conductivity cannot be measured until after the coating has cured.

4. Generation 2 floors cannot be re-coated without applying both a new ground- plane and a new top coat. As stated above, the top coat thickness must be carefully controlled. Once a top coat is cured, at any thickness, any new application of top coat will render the floor non-compliant for both electrical resistance and walking body voltage.

5. Hot spots: Floors with conductive ground-planes can exhibit too much conductivity if the top coat is applied carelessly. We call overly conductive areas hot spots for the exact reason one would think. Too much conductivity can create an electrical hazard.

6. Moisture vapor controls: Generation 2 floors require materials that are intrinsically difficult for vapor to permeate. This means that they cannot be installed directly over high vapor slabs (high concrete RH per ASTM 2170). When the slab RH exceeds 80 to 85%, an epoxy vapor barrier is required. These vapor barriers are expensive, they add time to the schedule, and they need to be installed perfectly in order to work. This is one more unnecessary variable.

Figure 1: *Exposed black primer on Gen 2 ESD floor from impact damage.*

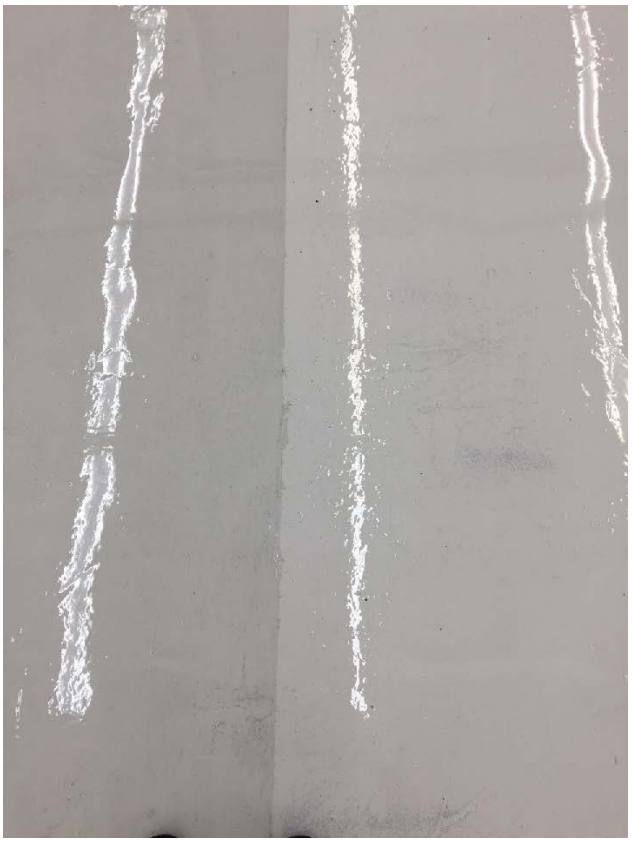


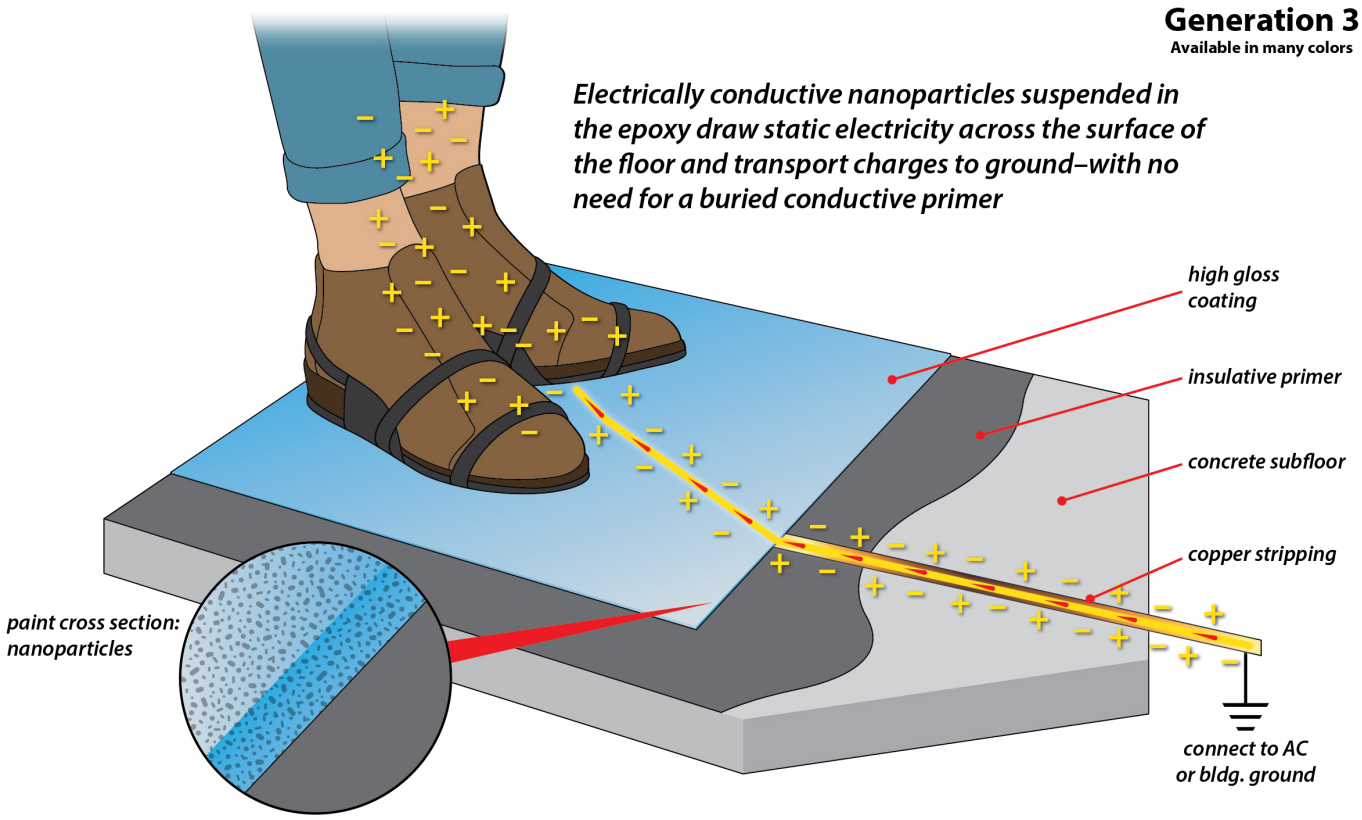
Figure 2: *Exposed black primer on Gen 2 ESD at saw point.*

GENERATION 3 FLOORS: ELIMINATE VARIABLES

New additive technologies enable us to produce fully conductive colorized top coats (colored and clear). This translates to a floor that requires a standard concrete primer, one layer of top coat and no conductive primer layer. The biggest benefit of the solution: The conductivity is on the surface and the conductivity is no longer thickness dependent. In other words, we have eliminated the two main variables that contribute to performance failure.

Because the conductivity is at the surface, we can provide a coating with extremely low tribocharging properties with any ESD footwear at any humidity level. A thinner top coat provides the added benefit of being less vulnerable to blistering and vapor problems from high RH concrete. In most cases Generation 3 floors can be installed at ASTM 2170 RH numbers as high as 95%. This enables installations over relatively new concrete.

In the event a Generation 3 floor requires a repair in an area that was heavily abused by frequent dragging of wooden pallets with protruding nails, a new top coat can be applied directly over the existing floor. The new surface will become the new path to ground. Generation 3 coatings can be applied directly over old coatings after sanding. This is impossible with old technology Gen 2 conductive ground-plane-reliant coatings.



Nano technologies produce fully conductive colorized topcoats (colored and clear). This translates into a floor that requires a standard concrete primer and conductive topcoat.

GROUNDWORX ULTRA – A HIGHLY DURABLE GENERATION 3 COATING

1. Generation 3 floors do not rely on a black conductive ground plane for conductivity. Generation 3 coatings obtain their conductivity and low charge generation properties from the top coat.

2. GroundWorx Ultra meets all aspects of ANSI/ESD S20.20-2014. It can be formulated in either the conductive (< 1.0×10^6) or the static dissipative (10^6 to 10^9) range.

3. GroundWorx Ultra allows for the use of any type of ESD footwear while still meeting the ANSI /ESD 20.20 requirements of less than 100 volts charge generation for a flooring/footwear combination.

4. Generation 3 systems are easier to install than Generation 2 floors. Controlling the thickness of the top coat of a Generation 3 floor is far less critical than it is with a Generation 2 floor.

5. The base primer of a Generation 3 coating is non-conductive, available in any thickness and pigmented to match the top coat. A matching pigment primer eliminates the aesthetic problems caused when a coating is scratched or gouged. A scratch will never contrast with the color of the top coat.

6. Generation 3 floors can be recoated without the need to apply any ground plane coatings.

7. GroundWorx Ultra is a urethane-based polymer. Urethane is significantly more scratch-resistant than conductive epoxy resins.

8. Generation 3 conductive coatings can be applied directly over old coatings, VCT and concrete.

Insulet, 60,000 sq.ft., Gen 3 epoxy, slip-resistant finish

ESD COATINGS	GENERATION 1	GENERATION 2	GENERATION 3 GROUNDWORX ULTRA	GENERATION 3 GROUNDWORX BASICS
Electrical resistance can measure in the conductive or dissipative range	NO	YES	YES	YES
Available as a counductive or dissipative product	NO	YES	YES	YES
Does not require a conductive ground plane	YES	NO	YES	YES
Available in light colors	NO	YES	YES	NO
Meets ANSI/ESD S20.20-2014 with foot straps	YES	NO	YES	YES
Can be applied over existing flooring in a single coat	YES	NO	YES	YES
Glossy finish without application of ESD polish	NO	YES	YES	NO

StaticWorx®
372 Hurricane Ln Suite 201,
Williston, VT 05495
staticworx.com

617-923-2000
f: 617-467-5871
info@staticworx.com