ZIRCONIA™
Ending Concrete Corrosion

Zirconia's Positive Environmental Impacts

CeramycGuard, a Ceramic Surface Treatment (CST), is an inorganic polymer (alumina-silicate) that seals and protects the surface of concrete from chemical attack, stopping corrosion from environmental exposure, including carbonation (from carbonic acid in rain) and salts. This coating restores, protects, and preserves concrete indefinitely, dramatically improving the durability and extending the lifespan of concrete-built infrastructure.

This CST coating technology is a revival of Roman Cement as a nano-ceramic coating, with the same lifespan as Roman Cement mortars that built the Colosseum and Pantheon, still standing after 2,000 years. This extended lifespan is transferred to modern concrete structures when coated.

Zirconia's CST coating technologies preserve concrete assets by preventing intrusive surface corrosion. This protective process creates substantial environmental benefits by restoring and protecting existing infrastructure, thus, preventing the need to continually demolish and rebuild concrete structures.

Ceramic Surface Treatment coatings and associated technologies from Zirconia include:

A. **Ceramic Surface Treatment coating systems**
   - CeramycGuard Ceramic Surface Treatment (CST)
   - CeramycGuard base, with ComposiCoat BP Topcoat
   - CeramycGuard base, with ComposiCoat XD Topcoat
   - CoolColors heat reflective coatings

B. **Colloidal Nano-Silicate particles**: penetrating curing/sealing agents (densifiers)

C. **Ceramic Cement Mortars** Alumina-silicate repair mortars (actual Roman Cements)
   - Flowable fill
   - Repair mortars

The use of Zirconia's Ceramic Surface Treatment (CST) coatings, and related ceramic cement technology, has multiple positive environmental benefits, including:

1) Dramatic durability increase - extending lifespan of concrete assets
2) Reduces greenhouse gases (GHG) from virtually immortal lifespan (multiples of engineered lifespan)
3) Lowers need for maintenance, and environmental impact of maintenance (lower frequency and extent of maintenance lead to lower environmental impact)
4) Heat reflective coating technology, lowers electricity draw and related CO_2 emissions
5) Low greenhouse gas products, meaning low GHG manufacturing footprint

6) CeramycGuard is green chemistry, water-born, non-toxic coating technology
7) Provides safer food & water quality due to antimicrobial characteristics of CeramycGuard

Preserving Old & New Infrastructure Indefinitely

1. Dramatic Durability Increase: When evaluating large scale infrastructure, the main long-term driver of environmental sustainability is the durability of the concrete asset. Concrete has a high imbedded carbon load, so concrete assets are inherently "carbon expensive". Loss of concrete assets due to salt corrosion creates a loss of the invested carbon, as well as the function of the asset, and may result in other economic and environmental impacts. Increased surface durability extends the lifespan of existing concrete structures and lessens the need for asset reconstruction, which generates massive new carbon emissions. So, bottom line, Zirconia technology stops the loss of invested carbon, and also stops new carbon emissions from the re-extraction of raw materials, remanufacture of concrete/steel and reconstruction of concrete infrastructure. Basically, it stops the concrete corrosion cycle (corrode-demolish-rebuild-repeat).

2. Getting to Net Zero Infrastructure: Concrete corrosion (chemical erosion) occurs at the surface of concrete and works inward as the asset decays. When the surfaces of concrete structures are coated with CeramycGuard, the alumina-silicate coating chemically bonds to the concrete surface forming an ultra-durable ceramic composite layer, which is immune to corrosion from carbonation, salts, and weathering. This effectively stabilizes the chemically unstable surface of the concrete, preventing corrosion, and preserving the entire asset. Since the global impact of the manufacture, and construction of concrete structures, is estimated to be as much as 12% of global CO2 emissions, surface stabilization of this type can directly limit the need to renovate and rebuild major concrete infrastructure, reducing greenhouse gas emissions dramatically.

3. Life Cycle Extension - Existing Concrete Structures: Zirconia's Ceramic Surface Treatment coating technologies restore, protect, and preserve existing concrete structures by creating a composite ceramic barrier layer that is immune to heat, salt, weathering, and carbonation, which are the main causes of surface intrusive corrosion. Since corrosion happens from the outside inward, this barrier layer preserves the concrete asset entirely, creating an indefinite lifespan asset. Also, since the CeramycGuard coating bonds into itself (unlike plastics), and can repair wear damage repeatedly over time, there is no reason that a concrete structure ever has to wear down. They can achieve virtual immortality.

4. Life Cycle Extension - New Concrete Structures: Zirconia's Ceramic Surface Treatment coating technologies improve the quality of concrete, eliminate cracking and porosity, thus, protecting the surface of concrete from intrusion by salts and other chemical contaminants. The CeramycGuard base and topcoat technologies bond back into themselves, allowing for an infinite number of renovation cycles, without allowing degradation of the primary concrete asset. Thus, the CO_2 calculation associated with new asset lifespan can be extended forward in time, reducing the overall value of CO_2 expense year-over-year during the engineered lifecycle period.

5. Reducing GHGs: Consider a bridge which might last 50 years in the environment without CeramycGuard coating. It may, however, be preserved for over 500 years with CeramycGuard coating and minor maintenance. One would have to build 9 additional bridges over that period, versus a single use of this Ceramic Surface Treatment coating technology. Thus, the GHG emissions savings within this example would be over 900%. While we cannot be sure how long the "indefinite" lifespan is, it is certainly well past a human lifetime. Keep in mind that Roman Cements, which are similar to CeramycGuard chemistry, have lasted 2,000 years and are still intact (e.g., the Pantheon). Zirconia's coating technology will at least double the life of every asset. But likely, in most instances, the lifespan of the asset will simply be "indefinite" given the impact of elevated surface durability and the elimination of wear and surface corrosion.

6. . Reduced Maintenance: Zirconia's CST coating system technologies create ultra-durable surfaces that need very little maintenance. Zirconia's CeramycGuard coating is similar to granite - it is basically liquid stone. So, it is not affected by heat, sun, or salt. The surface is oxidative and photocatalytic, meaning it is self-cleaning in the presence of sunlight, and will not be degraded by biological growth.

This means the amount of maintenance related to repair and recoating of concrete for corrosion protection goes down dramatically, reducing maintenance time and expense accordingly.

The colloidal nano-silicates (alumina-silicates) interact with alkali (calcium) in the concrete, forming more CSH binder, eliminating capillaries and porosity in concrete. This process pushes out salts in the treated zone (up to approximately 20 centimeters), neutralizes remaining salts in the treated zone, and re-alkalinizes rebar. This treatment densifies the concrete, which lessens the degree of carbonic acid and salt intrusion, lessoning corrosion.

7. Heat Shielding: Zirconia has invented a ceramic heat-reflecting coating technology called CoolColors™ which has a 98% Solar Reflective Index (SRI) rating. This coating is made in white, light blue, pink and tan. Thermal expansion and contraction create additional stress on concrete assets, which can be lowered by lowering the absorption if infrared energy from the sun. This heat reflective coating technology is expected to reduce the thermal absorption of buildings and bridges, reducing thermal stress experienced by the structures. This will help protect these structures from cracking and structural wear, thus reducing the need for expensive renovation cycles, and shortened lifespan in hot environments.

This technology is also expected to reduce the heat-island effect on cities. When CoolColor coating technology is used to coat buildings, it will significantly reduce the need for electricity for air-conditioning, and thus reduce the need to burn fossil fuels for air-conditioning electricity draw, reducing CO2 emissions in the process. Variations of this technology can be used to cool sidewalks and other concrete structures in public areas, reducing heat-stress on the public.

Finally, these various heat reflective CST coating systems will serve the additional purpose of creating greater opportunities for beautification of bridges and buildings. Also, CoolColors coatings are highly photocatalytic and self-cleaning, thus reducing maintenance.

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8. Low GHG products: CeramycGuard technology is made from recycled industrial products and generates very low CO_2 from production. It generates only 10% the CO_2 emissions of epoxy and polyurethane coating systems. Zirconia's CeramycGuard is water-born, and does not require organic solvents. Thus, Zirconia's coating products will always have lower GHG emissions in comparison to organic coating technologies (epoxy, polyurethane systems).

Further, our ceramic cement mortars are also made with recycled industrial waste products and represent low embedded carbon mortars, generally only 30-50% the carbon input of portland-type cement mortars.

9. Green Technology (Reduced Toxicity): As a green-tech company Zirconia is always pushing the boundaries of green chemistry to make our coatings and other technologies less toxic, while keeping the best performance characteristics.

For instance, our CeramycGuard technology is water borne, not solvent borne, meaning it does not expose workers to toxic solvents. This is a huge advantage for "inorganic" chemistries like ours, which can be suspended with water, where organic chemistries cannot be.

For our organic topcoats, we are using green solvents that have low toxicity. Also, we are using a high-solids, ultra-low VOC solvent strategy for heavy organic coatings. In all cases we are working toward reducing the hazardous characteristics of coatings to be as "clean tech" as possible while still meeting our durability standards.

10. Safer Food Production: CeramycGuard is made of alumina-zirconia-silicates which are highly antimicrobial to bacteria and other microbial life. Also, CeramycGuard eliminates porosity (habitat), eliminating the ability of bacterial biofilms to grow and penetrate concrete, which is the primary source of microbial infection in food manufacturing and water supplies. CeramycGuard generally eliminates the ability of concrete to host microbial life. This is true for the concrete floors and walls of factories, or water pipe infrastructure above or below grade.

The durability of the CST coating systems means that fewer cleaners/detergents are necessary to accomplish the goal of daily cleaning in food manufacturing. Also, due to the increased physical toughness of Zirconia's coatings, water pressure and greener cleaners can be used in substitution of harsher, more toxic cleaners used in the past. This means lower general impact on the maintenance workers, the sanitary sewer system, and the environment.

Additionally, some of the improved performance properties, like better non-slip technology, increases the safety of workers in industrial and food production settings.

One final Note: The synergy of these various Ceramic Surface Treatment technologies creates unique levels of durability with respect to concrete repair, renovation, and new construction because of their ability to chemically bond with each other and form durable composites with the surface of concrete.

These composite systems have the best traits of both inorganic ceramics and organic polymer types of chemistries, allowing them to survive extreme environments without damage for extensive periods of time, while also improving performance characteristics, and decreasing negative effects on the environment.