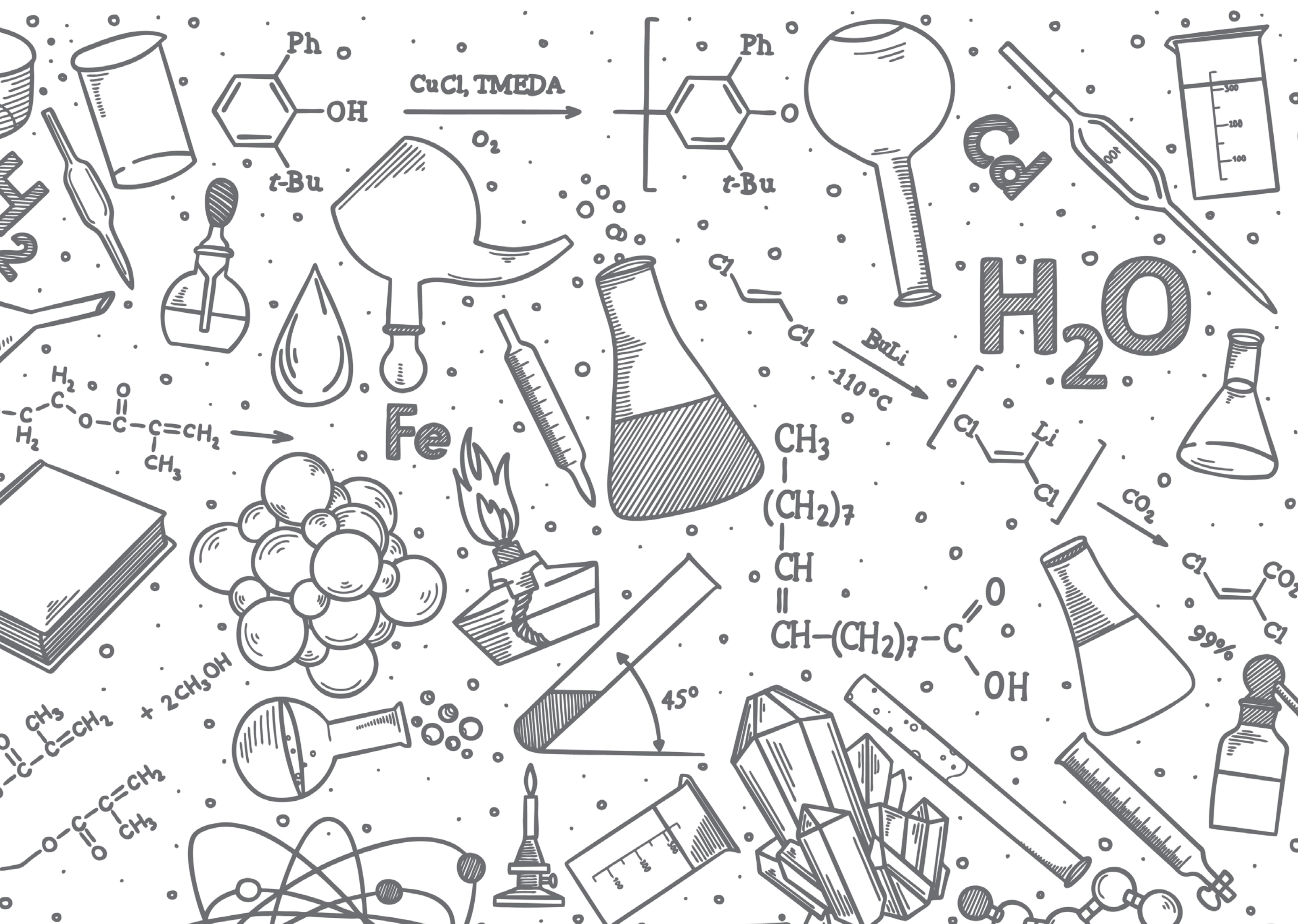
Nawkaw®

ARCHITECTURAL FINISHES INSPIRED BY ART & SCIENCE



THE SCIENCE OF MINERAL STAIN & PHOTOCATALYTIC TECHNOLOGIES

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Introduction

Nawkaw's products and services are designed to act as a conduit between the artistic vision of architects and the scientific demands of building construction and sustainability. Finding the harmony between these seemingly opposing forces is no easy task.

Nevertheless, Nawkaw's research and development has always aimed to create finishes that add depth, complexity, and color to structures, match architectural aspirations, and utilize the latest scientific innovations to ensure Nawkaw products lead the industry.

Nawkaw products cover a wide range of needs and requirements for our clients. However, two foundational technologies lie at the heart of what we do. Our mineral stain technology and our photocatalytic technology are designed to breathe life into substrates, imbue them with color, and even extend the lifespans of the buildings on which they are placed.

Nawkaw's ability to create architectural finishes lies in large part in the chemical makeup of our products. Through a stronger understanding of the science of architectural finishes, it becomes clear exactly how Nawkaw's products can bring innovative solutions to architects, project managers, and the industry as a whole.

Mineral Stain Technology

Many of Nawkaw's finishing systems and solutions are based on mineral stain technology. Bringing long-lasting color to concrete, masonry, and similar surfaces is no small task. However, Nawkaw's system relies upon the chemical properties of silicate binders, silicification, and substrate permeability to bring complex finishes to life.

Paint vs. Stain

Paint is a common color solution for many substrates, so it is no wonder why stain is so often compared to it.

Paint and stain may present aesthetically similar appearances on concrete and other such substrates. However, that correlation is only skin-deep, and the fundamental difference between their application is what makes stain the superior choice for concrete finishes.

The porosity of concrete creates unique problems for latex coatings. When paint is applied over concrete, it traps air, dirt, water, and other debris between the concrete's surface and the paint itself. These imperfections expand and contract over time and often result in chipped or cracked paint. Simultaneously, exposure to the elements fades the color painted onto the building in many cases.

Both inherent disadvantages of paint mean that concrete must be repainted several times—often exacerbating the problem. Contrast this to stain, which binds with the underlying concrete and forms strong bonds with the porous material. This bond is a chemical bond, resulting in no functional distinction between the stain and the underlying concrete.

With no entrapment of air, dirt, water, or other debris, properly applied mineral stain will not crack or peel. Mineral stain is also resistant to UV light, enabling pigments within the stain to retain their colors much longer than paint.

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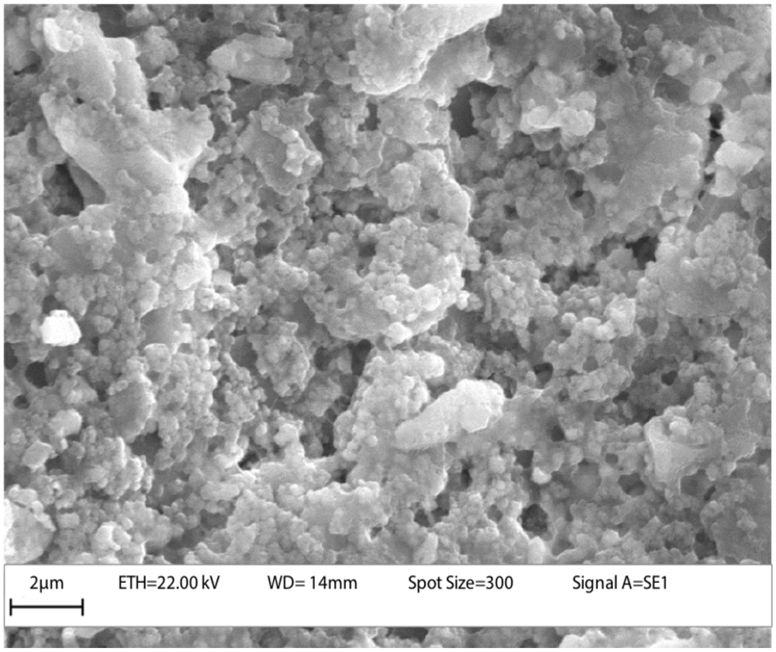
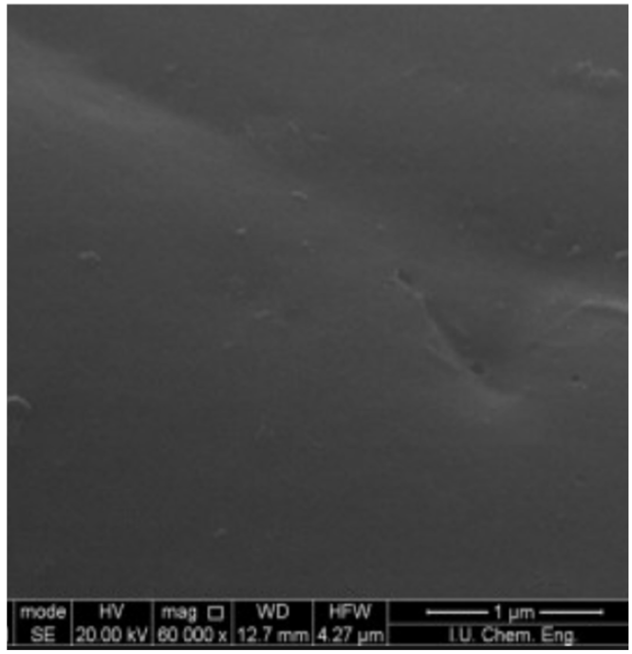
"Mineral stains form chemical bonds with underlying substrates. On a molecular level, there is no difference between the stain and the surface it is applied to. The strength of this bond, between stain and substrate, is fundamentally superior to latex paint—particularly in concrete and masonry applications."

Nawkaw Mineral Stain



Latex Coating



A scanning electron microscope image shows the drastic difference in porosity between latex paint and mineral stain. The water vapor permeance of mineral finish ranges from 75 to 90 Perms, which assures high breathability. Latex coatings, in contrast, form a film on top of the substrate. These films have low vapor permeance, usually in the range from 0 to 20 Perms. Moisture evaporating from the substrate causes a loss of adhesion and a lifting of the paint from the underlying surface.

Permeability

	Latex Paint	High-Quality Mineral Stain
Absorption per Day	W= 490 g/(m^2)	W= 440 g/(m^2)
Evaporation per Day	T=21 °C (69.8 °F) V= 95 g/(m^2)	T=21 °C (69.8 °F) V=2100 g/(m^2)

Permeance is critical for the longevity of any coating. The table above shows both high-quality latex paint and Nawkaw mineral stain's absorption and diffusion characteristics. As we will further explore, the ambient environment plays a vital role in a full understanding of the differences between coatings.

490 grams of water per square meter per day can penetrate through the acrylic paint system, and 440 grams per square meter per day can penetrate through high-quality Nawkaw mineral stain. These numbers are very similar.

However, at 21°C/69.8°F, the mineral stain allows 2100 grams of water to evaporate per square meter per day, while the acrylic paint allows just 95 grams of water per square meter per day to evaporate.

Drop the temperature down to 11°C/51.8°F, and 90% of the moisture in the wall will remain trapped by the latex paint at the end of the day. At the same temperature, the Nawkaw mineral stain enables four times more water to evaporate. This prevents the blistering and peeling that happens to paints when moisture remains trapped.

Water permeability of mineral stains also reduces damage from freezing temperatures. While standard coatings trap moisture and erode the substrate beneath, Nawkaw stain allows the underlying concrete to breathe.

Composition

Nawkaw mineral stains are comprised mostly of water, mineral pigments, quartz sand, fillers, a unique silicate binder, and less than 5% of additives. This allows them to be highly environmentally friendly with low VOCs.

Quartz is a valuable material for stain production, with one of its benefits being better durability for the coating and the surface. A potassium silicate binder, also known as waterglass, is formed from quartz sand, potassium carbonate, and water. Potassium silicate is the base of many silicate stains and is essential to their performance.

Silicate binder technology is not commonly known, even though it has been around since the 1870s. However, since the late 19th century, advancements in technology and improvements to potassium silicate binders' manufacturing process have enabled their everyday use.

Silicification

Mineral stains showcase excellent durability, structural soundness, and imperviousness to pollution, acid rain, and severe weather patterns. Due to Nawkaw mineral stains forming chemical bonds with the surface or substrate they are applied to, they become a part of the substrate on a molecular level. The silicification of the binder with the substrate results in unparalleled durability.

Silicification occurs when the potassium silicate binder of the stain meets the calcium hydroxide of the substrate. The resultant potassium hydroxide from this initial reaction further reacts with the carbon dioxide in the air and forms potassium carbonate—resulting in the evaporation of the water within the substrate.

This is significant because not all silicate binders are equal. Sodium silicate is another binder that can be used in mineral coatings formulations. It produces sodium carbonate, a source for efflorescence, and is not used in Nawkaw products for that reason.

Photocatalytic Technology

Aside from mineral stain, photocatalytic finishing systems can be used to accelerate photoreactions in the presence of a catalyst. NawKote-PC is one such photocatalytic finishing system that can be used to make buildings more environmentally friendly—all through photoreactions.

Photoreactions themselves are chemical reactions that involve light or electromagnetic radiation to increase the energy of particles. For finishing systems such as NawKote-PC, this means that dust, grime, airborne pollutants, and similar substances are transformed into carbonates, water, sulfates, nitrates, and other molecules that are beneficial or otherwise have a benign impact on the environment.

The finishing system also attracts water to its surface, enabling water to get between the dirt and the finishing system, which allows it to be washed away—effectively making the finishing system self-cleaning. This is thanks to the titanium dioxide (TiO_2) nanoparticles found in the system itself.

Titanium Dioxide Forms

TiO_2 comes in three forms—rutile, brookite, and anatase. In photocatalytic finishing systems, rutile and anatase are the two which possess photocatalytic properties and can be therefore used in finishing systems. These two forms of TiO_2, when exposed to light, excite and move electrons from two different bands on an atomic level. Specifically from the highest occupied molecular orbital (HOMO) to the lowest unoccupied molecular orbital (LUMO).

It is also worth noting that the rutile form is less photocatalytic than the anatase form, and the thickness of the finishing system applied has an inverse relationship with the speed of the

“Photocatalytic finishing systems such as NawKote-PC utilize hydrophilicity to pull water molecules beneath dirt and debris found on the surface on the substrate. Rainwater will then wash both water molecules and debris away from the surface. This effectively ensures the substrate is self-cleaning.”

photocatalytic process. Therefore, highly trained technicians must be employed to handle the application process to specification.

There are also records and examples where rutile TiO_2 sometimes has higher activity and can be used when the noncomplete and selective photocatalytic activity of organic substrates is required. Using literature studies as well as our own studies, we compared both forms of TiO_2 and a mix of the two forms in the creation of our NawKote-PC finishing system.

NawKote-PC Application

Using NawKote-PC on top of NawTone-K and NawTone gives concrete buildings color and protects them simultaneously. When applied to the surface, anything metal needs to be covered due to the photocatalytic system’s oxidizing capabilities, which will corrode the metal.

Glass is also a viable surface for NawKote-PC application and will require no primer for the application process. Other surfaces viable for NawKote-PC application include ceramics, cladding, and similar painted surfaces.

Please note that the bond formed with painted concrete surfaces is mechanical versus the chemical bond created when it is applied to an unpainted or stained surface.

NawKote-PC Benefits

As previously mentioned, “self-cleaning” is one of the benefits of photocatalytic finishes and the NawKote-PC system. This promotes sterilization of the surface and prevents and breaks down bacteria that would promote microbial growth. This breakdown can occur even when the sun is blocked from the surface of the coating and makes titanium dioxide one of the most effective antimicrobial agents. Hydroxyl radicals accelerate the breakdown of Volatile Organic Compounds (VOCs), which generally emit a strong odor.

The radicals break down the bonds of the VOCs and oxidize them with the help of the photocatalyst, which turns them from organic gases to single molecules that are not harmful. This reduces any unpleasant and harmful smells these gases give off. Greenhouse gases and other air pollutants, such as chlorofluorocarbons (CFCs), are broken down by photochemical reactions and eventually can be removed from polluted areas.

One great aspect of NawKote-PC is the fact that it can reduce and prevent the carbonation of concrete. Carbonation of concrete can occur when atmospheric CO_2 reacts with the water in the concrete and forms carbonic acid. The carbonic acid reacts with the calcium compounds—mainly calcium hydroxide—and forms calcium carbonate. Reducing the calcium hydroxide in the concrete causes the pH to drop to 8.5 or lower.

The issue with this is that the steel-reinforced concrete needs a high pH to stabilize the protective layer. The low pH can cause the protective layer to deteriorate, which leaves the reinforcement open to corrosion. Early-onset carbonation for concrete can contribute to the tensile and compressive strength of the concrete, which is beneficial for obvious reasons. Still, the negative effects of weathering carbonation are also worth noting in this case.

Preventing carbonation of concrete is accomplished by preventing CO_2 access to the surface of the concrete. This is done by protecting the pores of the concrete from the water and preventing ingress of the carbon dioxide in the water as well.

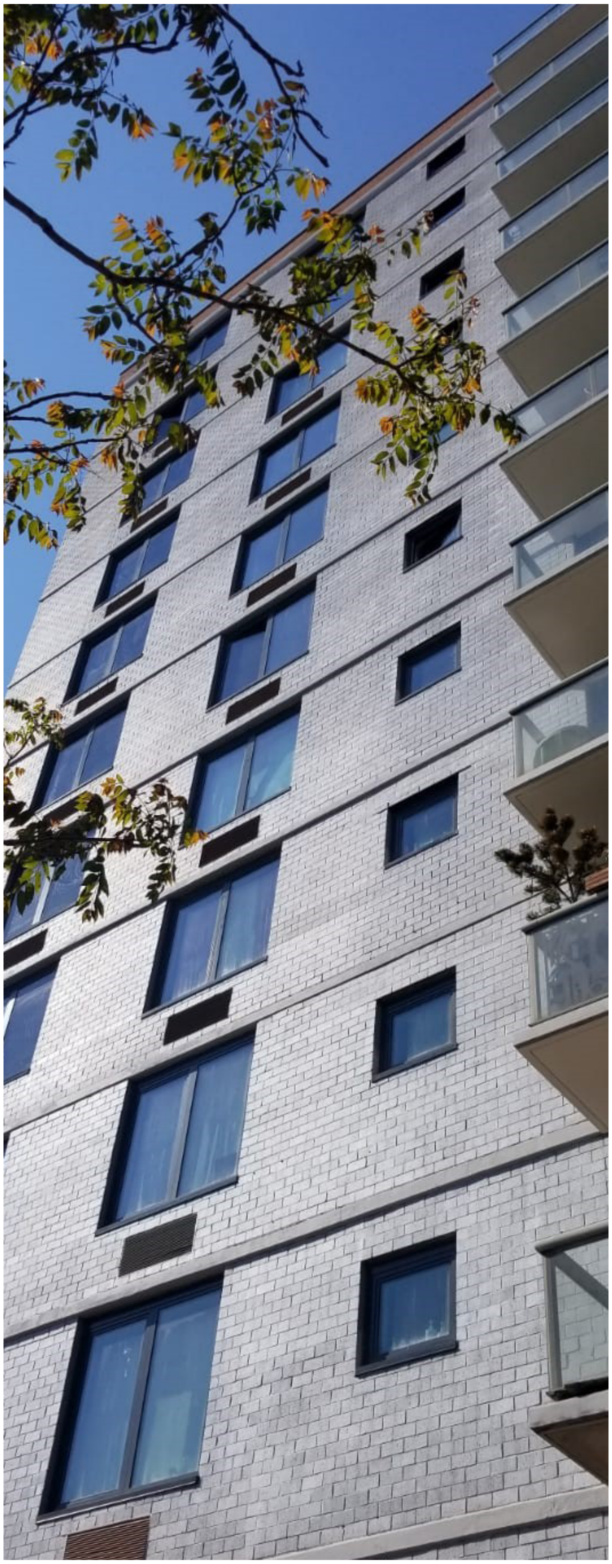
Investments for the Future

Through mineral, photocatalytic, and similar technologies, Nawkaw can provide sustainable solutions across a wide variety of use cases. Furthermore, photocatalytic technologies enable Nawkaw to preserve mineral stain applications and uncolored surfaces such as glass. This dramatically reduces the need for expensive and environmentally damaging cleaning chemicals and results in long-term savings as well as environmental preservation.

These technologies represent results for contemporary architects, designers, and building managers but are likewise investments for the future—reducing time spent on the maintenance and replacement of conventional paints and enabling structures to last longer through photocatalytic technologies.

Nawkaw's continued developments will work towards both current and future goals and align with our vision and mission.

We will always strive to invent techniques that deliver outstanding results, cause zero harm to nature, and breathe life into the structures you interact with each day.



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