



*The following article is based on a presentation given by Mr. Timothy Murphy of Mineralogy, Inc. for the Tulsa Chapter of the ACI, entitled “The Influence of Concrete Surface Contamination on the Performance of Low Permeance Flooring Systems.”*

## Beneath the Surface...

*Timothy Murphy, President, Mineralogy Inc.*

**Q**

*Cutting cores and obtaining lab analysis adds cost and time. Why test concrete?*

**A**

Certain types of contaminants commonly present in the near-surface layer of concrete slabs have the capacity to interfere with the bond development between resinous flooring systems and the concrete substrate.

The best adhesion between polymer systems and concrete occurs when the exposed cement paste is micro-porous and free of surface contaminants. Water-soluble salts, un-reacted curing compounds, hard surface cleaning products, and/or oil residues are types of contaminants that can block and inhibit the un-cured polymer from penetrating into the near-surface micro-pores of the substrate.

The majority of these contaminant materials are difficult if not impossible to identify via pre-installation inspection of the slab surface.

By knowing the composition, concentration, and approximate penetration depth of problematic contaminant phases, the installer and membrane supplier can design and implement a surface preparation strategy that ‘gets it right the first time’.

**Q**

*How is it that relatively small amounts of surface contamination can contribute to the wide spread failure of a flooring installation?*

**A**

There are a couple of main categories of surface contaminant materials that are known to interfere with the development and maintenance of a good bond between a resinous flooring system and the concrete substrate.

Water-soluble inorganic salts (including chloride compounds, certain sulfate compounds, and un-reacted metasilicate residues) are examples of inorganic surface contaminants that have been linked to flooring system failures. These inorganic residues commonly occur as microscopic precipitates that are intimately commingled with the cement paste components of the concrete.

Depending on the concentration and vertical distribution of these contaminants in the uppermost few millimeters of the cross section, these phases can occupy critical boundary locations between the polymer and the concrete substrate, creating a vulnerability in the event of moisture condensation immediately beneath the membrane.

As the relative humidity within the slab increases & moisture vapor condenses at this boundary plane, these microscopic precipitates of water-soluble inorganic material are returned into solution, creating a scenario in which selected point locations along the boundary plane of the membrane with the substrate are compromised by the development of microscopic films of water molecules.



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As the water chemistry changes with further moisture vapor transfer and condensation beneath the membrane, the concentrations of total dissolved salts may increase significantly, creating a chemical imbalance that can serve as the driving force for osmosis.

Organic residues, including oil & grease hydrocarbons, vegetable oils, and cleaning product residues comprise a second major category of near-surface contaminants commonly encountered in concrete slabs.

Many of the organic contaminants occur as thin, surface-wetting films that can block or diminish the penetration of the un-cured polymer into the near-surface micropores of the concrete.

As moisture vapor accumulates & condenses beneath the membrane system, the coating layer is increasingly susceptible to the development of blister defects.



### Our Approach

Despite the well-known problems associated with the application of low permeability flooring products on contaminated concrete, relatively few analytical methods exist to adequately identify these contaminants prior to installation. Laboratory techniques and methods developed and introduced to the coatings industry by Mineralogy, Inc. personnel, have made it possible & cost effective to evaluate the composition and approximate penetration depth of many near-surface contaminants prior to installation of the membrane system.

**XRD** X-ray diffraction (XRD) and energy dispersive x-ray analysis have been utilized in the characterization of the mineralogy and elemental chemistry of near-surface concrete materials. The XRD test method can identify the mineral composition of aggregate grains and cement components, as well as crystalline authigenic precipitates deposited following evaporation of transient moisture vapor solutions. The XRD test method is critical for the identification of a variety of efflorescent mineral phases and is fundamental to the investigation of sulfate mineralization and diagenesis in concrete structures.

**QOE** Quantitative organic extraction (QOE) and infrared spectroscopy (IR) analysis have been utilized for the identification of organic contaminants within concrete slabs. These test methods evaluate the total concentration and type of organic residue extracted from the uppermost 3 mm of the concrete core cylinder. Depending on the exposure history of the slab & visual appearance of core cylinder cross section, additional 3 mm thick profile depths can be evaluated via the QOE method to assess the vertical concentration gradient where appropriate.

**IC** The ion chromatography (IC) test method has been utilized to assess the secondary concentration of water-soluble inorganic compounds in the near-surface profile horizons of concrete core cylinders. Our R&D work employed in the initial development of this test method identified five ionic species that are critical to the recognition of common, inorganic surface contaminants in concrete slabs.

The ion chromatography (IC) assessment evaluates concentrations of water-soluble sodium, potassium, lithium, sulfate, and chloride ions. With the exception of lithium, all concrete slabs contain moderate levels of these ionic species.

Based on a database amassed from the analysis of several thousands of concrete core samples over the last ten years, we are confident in our ability to identify and differentiate between 'normal' ionic distributions and concentration anomalies and gradients associated with the most common types of inorganic concrete surface contaminants.

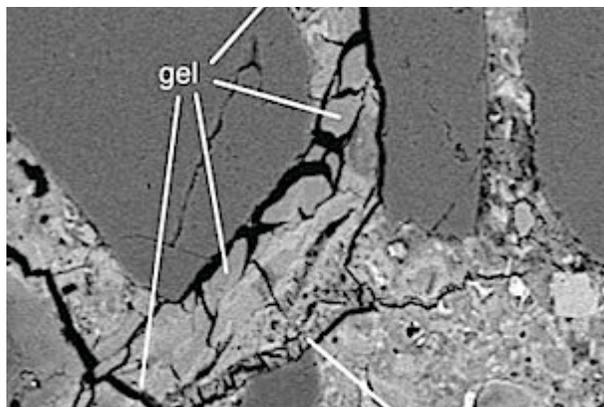


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**TSP** Thin section petrography (TSP) is a test method that evaluates the mineralogy, texture, and fabric of concrete in accordance with ASTM C856 (Standard Practice for Petrographic Examination of Hardened Concrete).

Concrete installations characterized by indications of cohesive instability (e.g., surface pop-outs, spalling, and excessive microfracture networking) are potential candidates for petrographic evaluation.

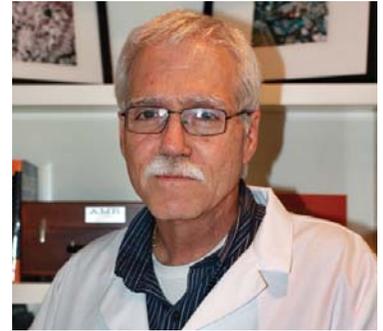
This method includes an evaluation of the aggregate population for indications of alkali corrosion [including ASR (alkali silica aggregate reactivity) & NSAR (near-surface alkali reactivity)]. The TSP method is oftentimes the principal investigative approach for evaluating concrete mix design properties, surface finishing anomalies, and coating system failure assessments.



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*Mineralogy, Inc. is a geological & geotechnical testing laboratory in business since 1979, specializing in the evaluation of mineralogical and chemical factors that can contribute to accelerated rates of moisture transmission and the cohesive degradation of hardened concrete.*

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