

# Breakthrough Chemistry- Platform Technology Dossier

## Three Modular Chemistry Platforms Engineered for Next-Generation Performance Portfolios

Prepared by **Breakthrough Chemistry Inc. (BKTH)**

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### I. Executive Summary — Why Large Chemical & Coatings Suppliers

Large chemical and coatings suppliers occupy a critical position in the global materials ecosystem. With broad portfolios spanning industrial, architectural, protective, marine, automotive, packaging, specialty materials, construction, healthcare, and infrastructure markets, these organizations are under increasing pressure to deliver higher performance while simultaneously reducing environmental, health, and regulatory risk.

Across the industry, sustainability commitments have evolved from aspirational targets into operational imperatives with board-level and investor-facing accountability. Regulatory pressure on legacy chemistries continues to accelerate globally, particularly for fluorinated surface treatments, halogenated fire retardants, metal-leaching antimicrobials, high-VOC coatings systems, and additive-heavy formulations that create downstream waste and lifecycle exposure. At the same time, customers expect demonstrable performance gains that cannot be delivered through incremental reformulation alone.

The next phase of competitive advantage in the chemical and coatings industry will be defined not by individual products, but by access to **fundamentally new platform chemistries**—systems capable of scaling across substrates, applications, and markets while delivering performance, sustainability, and regulatory durability simultaneously.

**Breakthrough Chemistry Inc. has developed three such platforms:**

1. **SiO<sub>2</sub>-based surface conditioning**
2. **Fire-inhibitor mineral systems**
3. **Stabilized halogen (N-halamine) chemistry**

These platforms are modular, interoperable, PFAS-free, and engineered for integration into existing formulation, manufacturing, and distribution infrastructures. They are not single-product innovations. They are chemistry systems designed to extend portfolios, close performance gaps, and enable entry into high-value applications without requiring asset-heavy upstream manufacturing.

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## II. Institutional Knowledge and Strategic Evolution

Most large chemical and coatings suppliers share a common historical arc. Over prior decades, many operated upstream materials businesses—precipitated silica, specialty minerals, fillers, functional additives, and surface intermediates. These businesses were technically credible and commercially productive, but over time became increasingly capital-intensive, margin-compressed, and exposed to commoditization pressures.

As corporate strategies evolved, many organizations divested these upstream operations. These divestitures were not technical failures. Rather, they reflected deliberate strategic decisions to redeploy capital and focus on higher-value activities: formulation science, surface engineering, application performance, regulatory positioning, and customer-specific solutions.

Crucially, while manufacturing assets and product lines were sold, the **institutional knowledge did not disappear**. Deep understanding of silica chemistry, mineral behavior, surface reactivity, coupling agents, dispersion mechanics, rheology, processing, and industrial scale-up remains embedded within science and technology organizations. This expertise is durable, transferable, and directly applicable beyond raw material production.

The strategic challenge for large suppliers today is not whether this knowledge still has value, but how to redeploy it in a manner aligned with modern business models, sustainability expectations, and regulatory trajectories.

### III. Platform Chemistry as a Modern Deployment Model

Platform-based chemistry provides a structurally different approach to innovation and growth. Instead of returning to capital-intensive raw materials ownership, platform systems allow materials science to be deployed inside **finished coatings, treatments, and integrated performance systems**, where value creation is defined by outcomes rather than tonnage.

In this model:

- Chemistry is engineered at the interface rather than through bulk loading
- Performance is delivered through surface behavior, not thickness
- Differentiation is maintained through bonding, network architecture, and application logic
- Regulatory and sustainability characteristics are inherent, not added late in development

Platform chemistry therefore resolves the core tensions that motivated earlier divestitures. It preserves technical advantage while avoiding exposure to commodity dynamics, heavy capital investment, and margin compression. It represents an evolution of materials science into system-level performance control.

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### IV. Platform Architecture — Three Modular Chemistry Systems

The Breakthrough Chemistry platform consists of three modular, interoperable chemistry systems that can be deployed independently or combined across a single substrate or product system. Individual products may evolve over time, but the platforms themselves are durable assets.

Each platform has been engineered for water-based or low-VOC delivery, compatibility with standard industrial application equipment, and scalable manufacturing. Integration does not require specialized tooling, new capital equipment, or non-standard processing environments.

## V. SiO<sub>2</sub>-Based Surface Conditioning Platform

### Strategic Purpose of the Platform

The SiO<sub>2</sub>-based surface conditioning platform is the foundational technology within the Breakthrough Chemistry portfolio. It is intentionally positioned at the intersection of inorganic chemistry, surface science, and applied coatings engineering, where large chemical and coatings suppliers already possess substantial internal expertise but limited access to next-generation, PFAS-free surface solutions.

This platform is not designed as a single product line or additive category. It is a **surface-engineering system** that allows performance traditionally achieved through fluorinated chemistries, sacrificial waxes, oils, or thick ceramic films to be delivered through chemically bonded silica architectures operating at the interface.

For large chemical suppliers, the strategic relevance is direct: this platform converts long-standing institutional knowledge of silica chemistry, silane coupling, dispersion, and scale-up into a modern, coatings-ready performance system aligned with current regulatory and sustainability trajectories.

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### Platform Overview

The SiO<sub>2</sub>-based surface conditioning platform modifies how materials interact with water, soils, oils, abrasion forces, UV radiation, heat, and environmental stress. Performance is delivered through **chemically anchored silica networks formed at the surface**, not through bulk fillers or applied films.

The distinction is fundamental. Traditional surface treatments rely on one of three mechanisms: sacrificial layers that wear away, hydrophobic oils or waxes that migrate, or brittle ceramic coatings that crack and delaminate when substrates move. The BKTH platform operates differently. It engineers surface behavior by controlling interfacial chemistry, resulting in performance that is durable, non-migratory, and intrinsic to the treated surface.

BKTH does not apply silica as a particulate additive.

BKTH engineers **surface behavior using silica chemistry**.

## Dual-Chemistry Architecture — Aqueous and Solvent Systems

A single chemistry cannot serve all substrates. For this reason, the platform deliberately includes two complementary chemistry families that share the same surface-engineering philosophy but differ in deposition logic and service envelope.

**Aqueous silica systems** are engineered for sensitive, flexible, porous, or in-service applications. These systems form bonded, sub-micron silica networks that integrate with the surface without building measurable thickness. Key characteristics include:

- Chemically bonded SiO<sub>2</sub> networks anchored at the interface
- Flexibility that accommodates substrate expansion, contraction, and bending
- Breathability and vapor permeability on porous substrates
- Preservation of surface optics, texture, and dimensional accuracy
- No peeling, cracking, hazing, yellowing, or migration over service life

These systems are suitable for polymers, vinyl's, biological surfaces, painted substrates, wood, masonry, and applications where in-service application or field deployment is required.

**Solvent-based silica systems** are engineered for high-abrasion, optical-precision, and extreme-exposure environments. In these cases, controlled thickness and hardness are advantageous rather than detrimental. These systems form durable bonded coatings that deliver:

- Abrasion and wear resistance under mechanical stress
- Optical clarity on glass, polycarbonate, and acrylic surfaces
- Long service intervals under UV, weathering, and chemical exposure
- Resistance to erosion, scratching, and repeated cleaning cycles

Selection between aqueous and solvent systems is governed by substrate mechanics, service environment, and performance objectives rather than formulation convenience or manufacturing preference.

## Substrate-Specific Coupling and Network Design

Surface performance is only as durable as the bond to the substrate. The platform employs a suite of coupling chemistries tailored to substrate class, surface energy, and mechanical behavior.

For inorganic substrates such as glass, ceramics, stone, and mineral surfaces, silane coupling systems provide covalent anchoring. For polymers, composites, and painted surfaces, hybrid organic-inorganic networks are used to balance adhesion with flexibility. For biological and semi-organic surfaces, coupling systems are designed to interact with cuticular or polymer-rich surface layers without extraction or damage.

Network architecture is selected to match substrate coefficients of thermal expansion, flexibility, and movement. Rigid networks are employed where dimensional stability is high; flexible networks are engineered where substrates move, flex, or cycle thermally. This substrate-specific design prevents microcracking, embrittlement, and delamination over time.

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## Flexible Network Engineering and Failure-Mode Avoidance

Conventional ceramic and sol-gel coatings fail predictably: microcracking initiates under stress, water ingress accelerates delamination, and performance degrades catastrophically rather than gradually. The BKTH platform was engineered with these failure modes as explicit design constraints.

By controlling precursor selection, coupling density, and network crosslinking, the platform produces silica architectures that dissipate stress rather than concentrating it. Abrasion resistance is achieved without brittleness. Flexibility is retained without sacrificing durability. Performance degradation, where it eventually occurs, is gradual rather than sudden. This approach fundamentally differentiates surface conditioning from traditional ceramic coating paradigms.

## Vertical Market Coverage and Application Logic

The SiO<sub>2</sub> platform has been engineered to address a wide range of vertical markets, each with distinct substrate and service requirements.

**Glass and optical surfaces:** Durable hydrophobic or hydrophilic tuning, contamination resistance, abrasion protection, and optical clarity on architectural glass, automotive glazing, display surfaces, and optical components.

**Plastics, vinyls, and soft polymers:** Soil release, easier cleaning, and surface protection without plasticizer extraction or loss of flexibility—critical for automotive interiors, aviation interiors, appliances, and consumer products.

**Industrial, marine, and aviation assets:** Reduction of contamination buildup, UV and weathering resistance, extended cleaning cycles, and in-service application compatibility for infrastructure and transport assets.

**Architectural and infrastructure surfaces:** Moisture management, soil resistance, and durability on façades, masonry, coated metals, and building envelopes.

**Energy systems:** Reduced soiling losses on photovoltaic panels, improved surface durability on wind turbine blades, and protection of exposed industrial energy assets.

**Agricultural and biological surfaces:** Reinforcement of surface cuticles, reduced trans cuticular water loss, and improved stress tolerance without acting as pesticides or nutrients.

All formulations are PFAS-free and nanoparticle-free by design, aligning the platform with tightening global regulatory environments and sustainability-driven procurement requirements.

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## Strategic Alignment for Large Chemical & Coatings Suppliers

For large chemical and coatings suppliers, the SiO<sub>2</sub>-based surface conditioning platform offers a direct pathway to re-enter silica-driven performance without assuming the risks associated with upstream materials manufacturing.

The platform aligns with existing strengths in formulation science, application engineering, and global manufacturing. It fills performance gaps left by the phase-out of fluorinated chemistries, extends service life and reduces lifecycle environmental impact, and scales across multiple business segments using a single chemistry system. Most importantly, it converts long-standing institutional knowledge of silica chemistry into a modern, defensible, coatings-ready platform positioned for long-term regulatory and commercial durability.

## VI. Fire-Inhibitor Mineral Platform

### Strategic Purpose of the Platform

Fire performance has emerged as one of the most structurally constrained problem domains in modern materials engineering. Regulatory tightening, expanding use of combustible materials, and increasing scrutiny of toxicity and smoke behavior have exposed fundamental limitations in legacy fire-retardant chemistry. For large chemical and coatings suppliers, the challenge is no longer whether fire performance is required, but how to deliver it **without relying on chemistries that are becoming commercially, environmentally, or regulatorily untenable.**

The fire-inhibitor mineral platform was designed explicitly to address this gap. It is not an additive swap or a reformulation of historical approaches. It is a materials-behavior control system that treats fire as a coupled, multi-stage process and intervenes across that sequence using mineral-based, halogen-free chemistry engineered for modern substrates and manufacturing workflows.

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### Fire as a Materials System Problem

Fire behavior is not a single event. It is a progression of interdependent phenomena: heat exposure initiates thermal decomposition; decomposition releases flammable gases; gas-phase combustion feeds heat back into the substrate; surfaces char, melt, crack, or drip; smoke and toxic byproducts are generated; and structural failure follows.

Most legacy fire-retardant solutions address only one step in this chain. Halogenated additives interrupt gas-phase combustion but generate toxic smoke and face regulatory phase-out. High-loading mineral fillers absorb heat but require loadings that destroy mechanical properties and manufacturability. Intumescent films protect surfaces but crack, delaminate, or fail under abrasion and are unsuitable for many flexible or porous substrates.

The BKTH fire-inhibitor mineral platform was architected to address fire as a **materials system problem**, controlling multiple mechanisms simultaneously rather than over-optimizing a single metric.

## Core Platform Architecture

The platform integrates five architectural advances:

1. **Multi-mechanism fire inhibition** — Formulations are engineered to coordinate heat shielding, char stabilization, flame-spread reduction, smoke suppression, and controlled heat release.
2. **Mineral-hosted functionality** — Fire-inhibiting functions are carried by engineered mineral structures that provide thermal stability, prevent leaching, and persist over the service life of the treated material.
3. **Low-loading effectiveness** — Performance is achieved without the forty-to-sixty percent filler loadings characteristic of legacy mineral systems, preserving mechanical strength and processability.
4. **Substrate-compatible binding logic** — Depending on the substrate class, the platform uses surface anchoring, matrix coordination, or composite integration rather than relying on brittle surface films.
5. **Industrial manufacturability** — All systems are water-compatible, scalable, shelf-stable, and consistent lot-to-lot, enabling deployment in global manufacturing environments rather than laboratory demonstrations.

The platform is halogen-free and metal-free by design, eliminating dependence on chemical categories under increasing regulatory restriction.

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## Deployment Forms and Integration Pathways

The fire-inhibitor mineral platform is delivered in multiple deployment forms to align with diverse integration pathways:

- **Aqueous surface treatments** for field application, retrofit, and maintenance on existing assets
- **Factory-applied coatings** providing controlled loading and durable treated surfaces
- **Additives for foams and plastics** engineered to integrate into polyurethane, thermoplastic, and thermoset systems without disrupting processing
- **Matrix additives for building materials** including gypsum, cementitious systems, and engineered panels
- **Mineral-hosted fire-inhibitor particles** serving as non-leaching functional fillers for coatings, plastics, composites, and construction materials

This flexibility allows the platform to address fire performance both during manufacture and post-manufacture, a capability not available with most legacy solutions.

## Vertical Market Coverage

The fire-inhibitor mineral platform is engineered to scale across a broad set of vertical markets.

**Wood and construction materials:** Treatment of structural lumber, engineered wood, panels, and boards where fire performance requirements are tightening globally and intumescent coatings are impractical or insufficient.

**Foams and insulation:** Fire inhibition in flexible and rigid foams, spray foams, and insulation systems—substrates where legacy chemistries are most problematic due to toxicity, smoke generation, and leaching.

**Textiles and soft goods:** Fire performance for upholstery, curtains, public-space fabrics, transportation interiors, and underlays without compromising hand feel or flexibility.

**Composites and plastics:** Integration into fiberglass systems, carbon-fiber composites, wood-plastic composites, and molded polymer components without high filler loadings.

**Packaging and paper:** Fire-resistant treatments for paper-based and engineered packaging materials where halogenated additives are increasingly restricted.

**Mineral and cementitious systems:** Functional additives for drywall cores, cement products, and mineral composites requiring durable fire performance.

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## Strategic Alignment for Large Chemical & Coatings Suppliers

For large chemical and coatings suppliers, the fire-inhibitor mineral platform provides a pathway to participate in next-generation fire protection without inheriting the regulatory, toxicity, and processing liabilities of legacy chemistries.

The platform extends existing portfolios into combustible substrate classes where traditional intumescent coatings or halogenated additives cannot serve. It leverages existing formulation and manufacturing infrastructure, supports sustainability and chemical stewardship commitments, and positions fire performance as a system-level feature rather than a compliance afterthought.

By treating fire as a materials-engineering problem rather than a chemical dumping problem, the platform delivers scalable, defensible fire protection aligned with long-term regulatory and market evolution.

## VII. Stabilized Halogen (N-Halamine) Platform

### Strategic Purpose of the Platform

Control of microorganisms, odors, and volatile organic compounds has become one of the most constrained and politicized problem spaces in modern chemistry. Regulatory pressure, resistance development, human-health concerns, and environmental persistence have progressively undermined confidence in traditional antimicrobial approaches. For large chemical and coatings suppliers, this has created a widening gap between market demand for durable hygiene performance and the shrinking set of acceptable chemistries available to deliver it.

The stabilized halogen (N-halamine) platform was engineered to close this gap. It offers a fundamentally different antimicrobial and oxidative control mechanism—one that is **surface-anchored, non-leaching, rechargeable, and self-limiting**—and therefore structurally aligned with modern regulatory, sustainability, and safety expectations. This platform does not compete directly with legacy disinfectants or biocides; it replaces the underlying paradigm on which they depend.

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### Why Legacy Antimicrobial Chemistry Fails

Most antimicrobial systems used today fall into one of five categories, each with well-documented limitations.

Free chlorine and bleach systems are highly effective initially, but volatile, rapidly depleted, corrosive, and unsuitable for continuous or long-duration control. Quaternary ammonium compounds rely on contact toxicity and suffer from rapid performance decay, residue buildup, and increasing resistance pressure. Phenolics and aldehydes present toxicity and environmental persistence concerns that limit their acceptable use. Metal-ion systems such as silver and copper depend on ion release, which introduces leaching, accumulation, and regulatory exposure. Time-release biocides function through migration and consumption, guaranteeing eventual depletion and driving repeated chemical re-application.

Despite differences in chemistry, these systems share two structural traits: they **leach or volatilize**, and they **depend on toxicity rather than localization**. These characteristics are increasingly incompatible with long-term surface hygiene requirements, especially in human-occupied, medical, food-adjacent, and enclosed environments.

## N-Halamine Chemistry — The Fundamental Difference

N-halamines are nitrogen-halogen compounds in which active halogen is covalently bound to nitrogen, forming stable N-Cl or N-Br structures. This bonding mechanism radically alters the behavior of the halogen. Rather than existing as a free, volatile oxidant, the halogen is retained at the surface and activated only under appropriate conditions.

Key inherent properties of N-halamine chemistry include:

- Covalently bound oxidative functionality rather than free oxidant release
- Non-leaching behavior; functionality remains localized at the surface
- Non-volatility; no off-gassing under normal conditions
- Rechargeability via simple oxidative sources
- Inert behavior when dry, activation only in the presence of moisture

These properties make N-halamines uniquely suited to applications requiring continuous, long-duration control without continuous chemical exposure.

## Historical Barriers and BKTH Engineering Breakthroughs

Despite decades of academic research, N-halamine chemistry failed to transition into industrial platforms due to five unresolved engineering barriers. BKTH solved all five simultaneously.

1. **Aqueous stability** — N-halamines were historically unstable in water. BKTH developed stabilization systems enabling long-term aqueous storage, spray ability, and consistent performance.
2. **Inorganic and mineral anchoring** — BKTH engineered methods to covalently and coordinatively anchor N-halamines to minerals, zeolites, and inorganic substrates without wash-out or deactivation.
3. **Humidity-activated functionality** — The platform remains inert when dry, activating only when moisture is present, then deactivating again as surfaces dry—mirroring real-world environments rather than laboratory conditions.
4. **Industrial coating and integration processes** — Uniform, scalable coating methods were developed that operate within standard industrial manufacturing workflows.
5. **Durability with rechargeability** — Surface anchoring, stabilizers, and crosslink control enable repeated recharge cycles without degradation of the host substrate or loss of performance.

Solving these barriers transformed N-halamine chemistry from an academic concept into a commercial, multi-substrate platform.

## Deployment Forms and Sub-Platform Expressions

The N-halamine platform is delivered through four primary deployment forms, all sharing the same stabilized halogen backbone.

**Surface-anchored aqueous systems** provide immediate cleaning and oxidation on application, followed by establishment of a stable invisible functional layer that reactivates in the presence of moisture.

**Coated minerals and zeolites** act as dry, solid carriers of oxidative functionality, suitable for embedding in composites, packaging systems, filters, and absorbent products.

**Absorbent polymer and composite systems** combine moisture management, odor control, and antimicrobial activity in environments where persistent dampness or organic load is present.

**Recharge chemistries** restore oxidative capacity to surfaces and solids, extending useful life and dramatically reducing chemical consumption and waste.

**From these delivery forms, three commercial sub-platforms emerge.**

### Sub-Platform I — Surface Hygiene and Odor Control

This sub-platform provides continuous surface hygiene and odor control in built environments without continuous chemical application. It manages odors, ammonia, VOCs, and microbial growth through localized oxidation rather than masking or bulk disinfection. Applications include residential, commercial, hospitality, transportation, and institutional environments.

## Sub-Platform II — Medical and Healthcare Materials

In medical and healthcare applications, the platform integrates into wound dressings, surgical pads, bedding, underpads, and medical textiles. The non-leaching, surface-anchored mechanism minimizes migration into tissues while delivering antimicrobial performance where moisture is present. Resistance pressure is reduced compared to release-based biocides.

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## Sub-Platform III — Food Preservation and Packaging

In food systems, the platform functions at the packaging and headspace level. Embedded N-halamine systems suppress spoilage-related VOCs and microbial growth without contacting the food itself. This reduces food waste, extends shelf life, and avoids the regulatory complexity of direct food contact additives.

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## Strategic Alignment for Large Chemical & Coatings Suppliers

For large chemical and coatings suppliers, the stabilized halogen platform unlocks participation in antimicrobial, hygiene, odor control, and preservation markets without dependence on chemistries facing resistance, leaching, or regulatory phase-out.

The platform integrates naturally into coatings, materials, and packaging portfolios, scales across markets, and aligns with sustainability and circularity objectives through rechargeability and non-consumptive performance. It represents a rare opportunity to redefine antimicrobial value creation around **controlled surface chemistry rather than chemical depletion**.

For organizations seeking durable differentiation in hygiene-related performance categories, the N-halamine platform offers structural rather than incremental advantage.

## VIII. Intellectual Property Position

Patent-pending filings cover silica coupling architectures, mineral fire-inhibition systems, stabilized halogen bonding and recharge, and multi-substrate deployment methods. The IP portfolio supports licensing, co-development, or acquisition structures at the platform level.

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## IX. Strategic Alignment for Large Chemical & Coatings Suppliers

The platforms extend existing portfolios without internal competition, fill performance gaps legacy chemistries cannot address, and scale across multiple end markets. Sustainability and regulatory advantages are inherent to the chemistry design rather than dependent on downstream mitigation.

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## X. Commercial and Engagement Framework

BKTH supports platform-specific or full-stack licensing, territorial or segment exclusivity, co-development arrangements, and potential acquisition of platform IP. Manufacturing is established and scalable, and integration does not require capital-intensive retooling.

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## XI. Core Thesis

This is not about creating new products. It is about **changing how chemistry creates value**. Platform systems allow large chemical and coatings suppliers to translate materials science into durable performance leadership without returning to the economic constraints of commodity manufacturing.

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## Breakthrough Chemistry Inc.

United States (Florida) • Singapore • Asia-Pacific