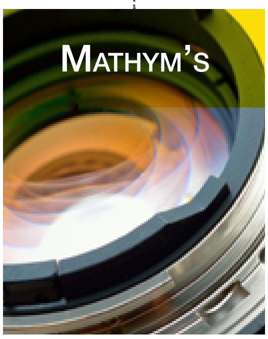
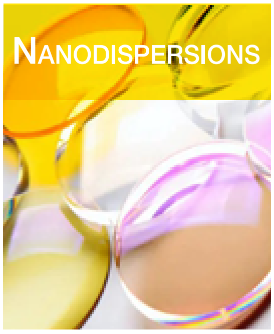
Baikowski®

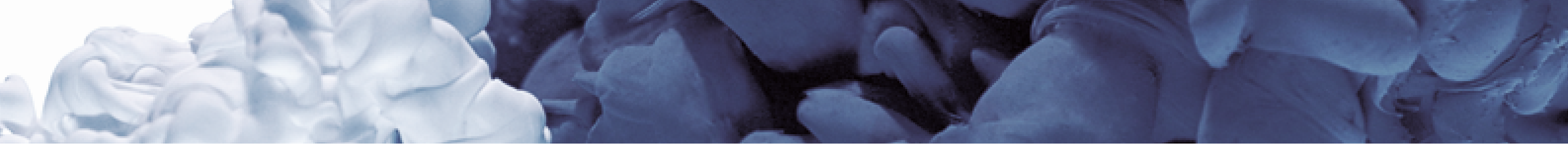
Solution partner for FINE MINERALS

ADVANCED MATERIALS FOR SUPERIOR OPTICAL & OPHTHALMIC COATINGS

ZILIGHT® NANO-ZIRCONIA







> Light plays a crucial role in our ability to see the world around us. However, the act of light interacting with our eyes isn't always perfect. Unwanted reflections, glare, and harmful UV rays can impede clear vision. With our increasing reliance on digital devices and the growing focus on preventive healthcare, consumers are seeking advanced lens solutions that offer superior visual clarity, comfort, and protection.

> This is where optical and ophthalmic coatings come into play.
Optical coatings are thin layers applied to optical components, such as lenses and mirrors, to enhance their performance by reducing reflections, increasing transmission, and protecting against environmental damage.
Ophthalmic coatings, specifically designed for eyeglasses and contact lenses, provide additional functionalities such as scratch resistance, anti-fog capabilities, and UV protection.

1. Optical & ophthalmic coatings

> **Anti-Reflective Coatings**
Reduce reflections from the lens surface, improving visual clarity and reducing eye strain.

> **Scratch-Resistant Coatings**
Increase the hardness of the lens surface to protect against scratches and abrasions.

> **Anti-Fog Coatings**
Prevent condensation on the lens surface in varying environmental conditions.

> **UV Protective Coatings**
Block harmful ultraviolet (UV) rays from reaching the eyes, protecting against long-term damage.

> **Hydrophobic Coatings**
Repel water and dust, improving lens maintenance and user comfort.

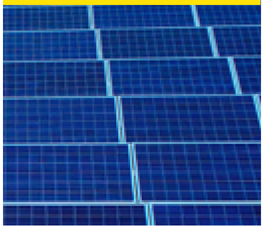
> **Blue light coatings**
Filtering blue light in order to increase comfort and functionality and minimize digital eye strain.

2. Main Applications

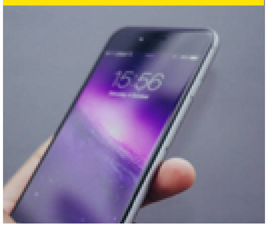
Automotive

Industrial

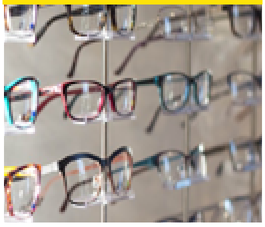
Energy



Imaging Industry & Electronics



Medical



3. Coating Challenges

Optical Coatings:

> **Stricter Performance Requirements**
With extremely demanding performance specifications like reflectivity, transmittance, and spectral filtering, even minor deviations can significantly impact the expected performance.

> **Environmental Durability**
When used in scientific instruments or lasers, they might need to withstand harsh environments like high temperatures, vacuum chambers, or exposure to specific chemicals.

> **Substrate Compatibility**
Optical coatings are applied to a wider variety of substrates beyond glass, such as polymers, crystals, and even metals that can be more or less challenging.

Ophthalmic Coatings:

> **Refractive Index Mismatch**
Incompatibility between the coating's refractive index and the lens material can cause unwanted reflections, reducing visual clarity and causing eye strain.

> **Consistency of Desired Properties**
Manufacturing processes complexity can sometimes produce inconsistencies in key optical properties, such as anti-reflectivity.

> **Uniformity and Thickness Control**
Achieving a consistently uniform and precise coating thickness, particularly on curved lenses, is challenging with traditional materials.

> **Surface Defects**
Uneven lens surfaces can result in coating inconsistencies or defects like pinholes or streaks, affecting both aesthetics and performance.

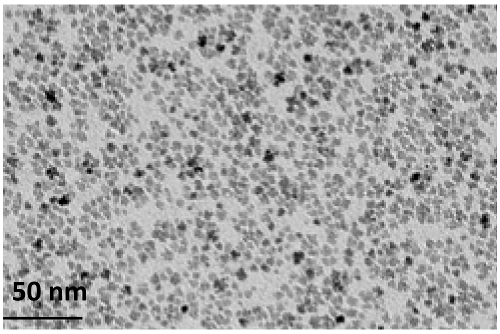
> **Compatibility Issues**
Certain coating materials and fillers may not be compatible with commonly used water-based resins in the ophthalmic industry.

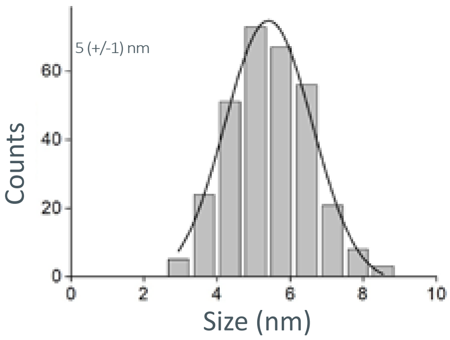
> These challenges entail the exploration of advanced materials and technologies to develop superior coatings. Nanoparticles offer a large number of advantages like improving optical properties, mechanical properties and hardness, and also comfort for the observer by filtering certain wavelengths (blue light).

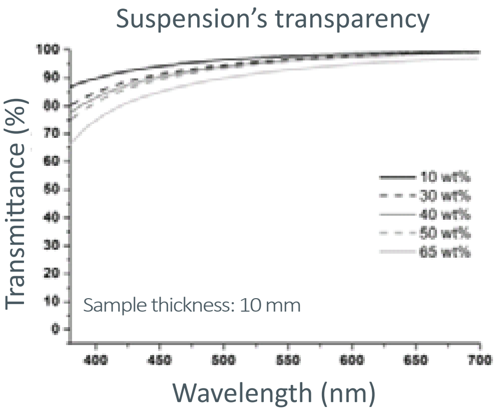
4. Mathym® Nano-Zirconia Benefits

zilight MATHYM

> Mathym®, a Baikowski® group company develops nanomaterials. Their nano-zirconia dispersions, zilight® exhibit **high refractive index and excellent chemical stability** that offer unparalleled benefits due to its:







> Ultra-Small Particle Size

With particles as small as 5 nm, free from agglomeration, it improves coating uniformity across the entire lens surface, even on curved geometries and minimizes light scattering within the coating.
This smaller size of nanoparticles also reduces the risk of them getting trapped by surface imperfections, minimizing the occurrence of defects like pinholes and streaks. Such properties allow exceptional clarity and minimal haze.

> Tailored Refractive Index

The dispersions can be customized to achieve a desired refractive index. This allows for precise control over anti-reflective properties, minimizing unwanted reflections and maximizing light transmission.

> Superior Mechanical Strength

zilight®'s nanoparticles improve the hardness and scratch resistance of coatings, extending their lifespan.

> Water-Based Compatibility

The dispersions are specifically designed for seamless integration with the water-based resins prevalent in the ophthalmic coating industry. This simplifies the manufacturing process and reduces reliance on potentially harsh solvents.

> Stable dispersions and variety of media

Mathym's advanced surface chemistries ensure stable dispersions, free from agglomerates, in various solvents.

> High Concentration Capability

The dispersions boast low viscosity, allowing for high concentrations (up to 70%) in water, ethanol, or solvent-based systems.

> By combining these exceptional properties, Mathym's nano-zirconia paves the way for a new generation of high-performance coatings that deliver **superior visual clarity, comfort, and durability.**

5. Optical and Ophthalmic Coating processes

> Processes usually implemented for optical coatings are based on **dip coating**, where the substrate is dipped in a bath containing the resin, or **spin coating**, where the resin is spread by centrifugal force onto a rotating substrate. This last method is ideal for thin, uniform coatings on flat or slightly curved surfaces like ophthalmic lenses.

> In both cases, a key parameter is the **resin viscosity** which impacts coating layer thickness and homogeneity. Thanks to their low viscosity, Mathym® suspensions can be integrated in standard resins without altering their behaviors and consequently their uses. Moreover, **high colloidal stability of our dispersions** allows an extended coating resin shelf life.

6. Coatings with zilight® 203 nanodispersion in Acrylic and PVA Resins

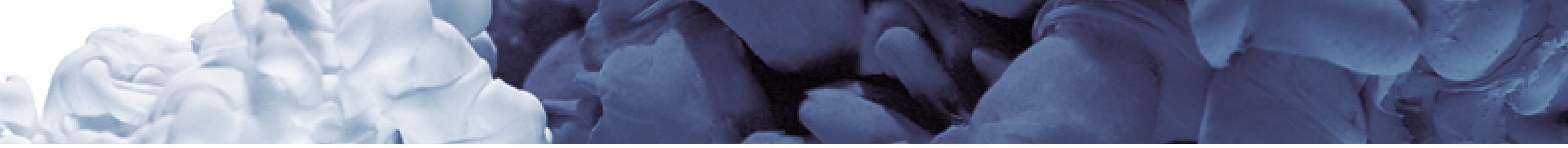
> Our product, zilight®, is available in various solvents and surface functionalizations to cater to specific application needs:

- zilight® 203, water based, acidic surface.
- zilight® 233, water based, basic surface.
- Other zilight® references are available on request in various solvents, with or without polymerizable groups on the surface.

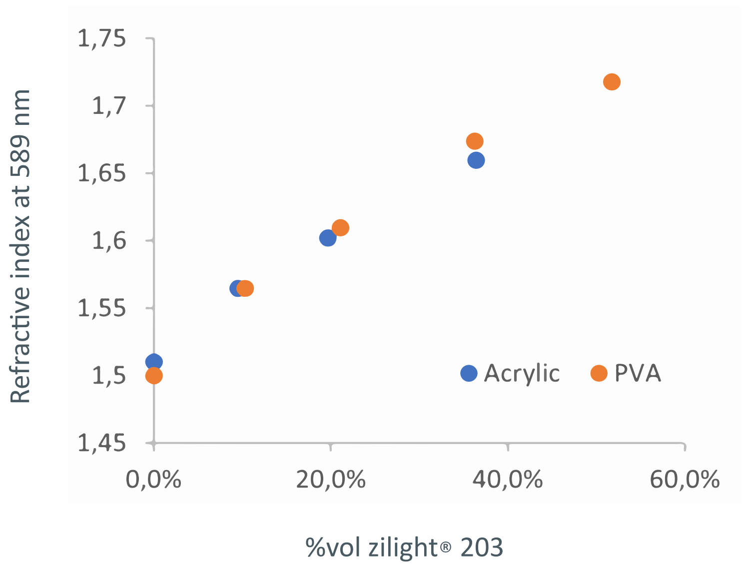
> Detailed examples of coatings with varying zilight® 203 loadings.

Matrix	Acrylic based			PVA based			
%wt zilight® 203*	30,0%	50,0%	70,0%	30,0%	50,0%	68,0%	80,0%
%vol zilight® 203*	9,5%	19,7%	36,4%	10,3%	21,1%	36,3%	51,7%
Coating refractive index n_D^{20}	1,565	1,602	1,66	1,565	1,61	1,674	1,718
Thickness	1 µm coatings			1 to 2 µm coatings			
Haze	<0.1	0,1	0,1	<0.1	<0.1	<0.1	<0.1

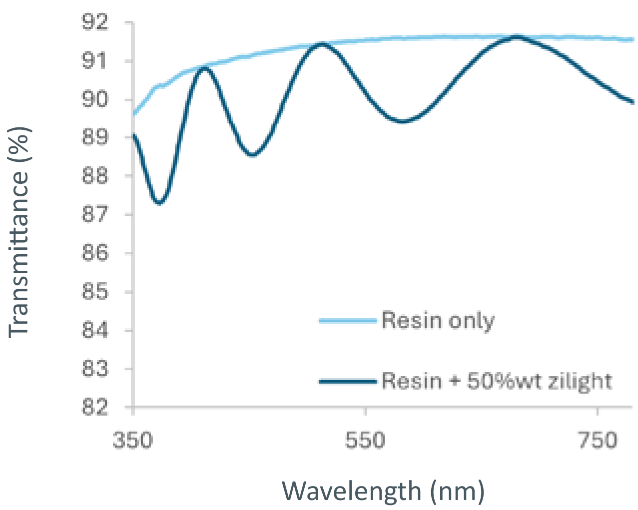
** Includes the stabilizing agent present on the surface of the nanoparticles*
Acrylic resin (VIACRYL) was provided by Allnex and filtered (1-2µm) before use. PVA (98000g/mol) was purchased from Merck.
Coatings were deposited by spin-coating (acrylic resin) or bar coating (PVA).
Optical measurements were done using a Jasco V770 equipped with a 60mm integrating sphere.



> Evolution of the refractive index with zilight® 203 loading in PVA and acrylic matrices



> Transmission curve of acrylic resin on glass and the same resin with 50%wt zilight® 203 showing a clear interference pattern with no absorption or scattering of light



PRODUCT DESIGN

> Contact us and we will develop together the product that meets your specific needs and requirements.

> Learn more about Mathym's zilight solutions

> Using zilight® has no or negligible impact on haze or transmittance even at high concentration, as long as the resin is compatible with the dispersion.

Mechanic properties of the coating are also improved compared to the bare resin. Those properties make zilight® an efficient and easy to use refractive index tuning agent, with unrivaled transparency, perfect for the realization of antireflective coatings below n=1.8.

Your solution partner for fine minerals

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