SURFACING SCIENCE™

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WASTE MANAGEMENT

The Other Side of Manufacturing

Regardless of where in the realm of optical manufacturing you are, waste is an inevitable consequence. How it's managed is critical to the success of any process. Fortunately, there are equipment solutions with the latest chilling, filtering, and processing technologies, to streamline the handling and application of slurry, water, coolants, and resulting waste. These unique systems address waste management from the standpoint of profitability and compliance. A well-engineered filtration system will payback its investment in consumable savings, reduced downtime, output quality, higher yield, lower waste removal costs, and environmental compliance. Systems can manage waste for smaller operations or be modularized for expansion.

Relying on the principle of sedimentation and centrifugal force, centrifuges and separators are capable of eliminating even the finest particles of silicate and plastic. Very popular in ophthalmic and precision optics, these systems maintain cleaner coolant, longer tool life, and higher flow rates. See **TURBO-HKS** below.

Filtration systems via membrane technology also eliminate harmful contaminants. Highly selective, sorbent filters of varying micron sizes, capture hazardous and nonhazardous impurities, resulting in a liquid stream suitable for normal discharge or recycling.

The MegaVap Liquid Eliminator from Universal Photonics, Inc.

The additional enhancement of chilling equipment will maintain constant, cool temperature, eliminate unwanted fluctuations, and dramatically reduce defects.

While compliant filtration systems will ready waste streams for disposal, removal is the next phase and usually, at an added expense. Solid waste, like the plastic chip by-product of CR39, can be reduced into compact bricks, either at the point of origin or integrated into larger central systems with **TURBO-HKS** compactor technology.

Evaporation, the thermodynamic process converting water to vapor, is perfect for de-watering waste streams with high solids concentration. A closed system, the **MegaVap** from **UPI**, reduces disposal volume, its associated cost, and maintains local EPA compliance with permissible discharge levels.

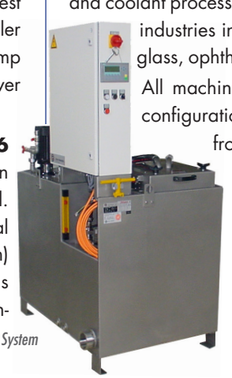
HIGH PERFORMANCE CENTRIFUGE SYSTEMS *With Built-In Coolant Processing*

Recently, **TURBO-HKS** introduced the **T06** & **T10**. Compatible with oil and water-based coolants, both systems can separate even the finest swarf from process fluids. Each maintains a smaller footprint that includes a built-in tank, supply pump and centrifuge, and hard plastic liner with cover fasteners for easy sludge handling.

Engineered for smaller optical machines, the **T06** system has a flow capacity of ~8gpm and filtration down to 1µ. It features an integrated cooling coil. The **T10** is suitable for a wider range of optical machines with a higher flow capacity (~25gpm) and supply pump customized to meet various flow/pressure requirements. The **T10** has an independent drop-in cooler.

Parent company, **TURBO-International Group** manufactures centrifuges, separators, compactors and coolant processing systems to service a variety of industries including precision optics, flat glass, ophthalmic, electronics, and ceramics.

All machinery is available in a variety of configurations and can service everything from a single machine tool to an entire production floor.



T10 System

T06 System

WHAT'S NEW...

Polishing Powder & Purity

How important is purity to achieving higher machining efficiency, sub-nanometer Ra, and micro-flatness?

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WASTE MANAGEMENT

Chilling, filtering, and processing technologies to handle slurry, water, coolants, and process waste.

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Ask An Expert: ON-SITE Q&A

Application engineers & polish technicians are on hand at every UPI/NUVITE trade show to address all surfacing questions.

For upcoming shows:
universalphotonics.com/events
nuvitechemical.com/events

AVIATION: PROTECTING YOUR ASSET

Navigating the Aftermarket of Special Purpose Coatings

Mention coatings in the world of aviation detailing and you'll be bombarded with information. Some of it on the money – some short-sighted – all of it in the service of protecting the appearance, performance, and safety of the aircraft.

For many passengers, a plane's pristine appearance reassures its airworthiness, an assurance not without merit. Modern design systems and Original Equipment Manufacturer (OEM) coatings, generally known as paint, provide the aesthetic and protection to assure performance under extreme conditions. Fabricated from a variety of materials, aerospace paint is the only type of exterior paint that must handle extraordinary temperature changes, plus moisture, UV light, oxidation, atmospheric pollutants, and aggressive chemical and cleaning materials.

Once the aircraft takes to the sky, that protection is under attack. At cruise altitude, a shiny appearance becomes lackluster and dull with high levels of UV exposure. The corrosive nature of oxidation disrupts airflow, degrading performance and compromising air safety. Aircraft maintenance programs, while critical, can be a drain on productivity. After all, aircraft are meant to fly, not sit in a hangar.

For a growing aerospace market demanding increased performance, improved aesthetics, and higher productivity, aftermarket coatings, a.k.a. special purpose coatings, offer the best solutions. Leading the charge is the exterior applications segment; a divergent group focused on establishing a hydrophobic barrier and shielding against UV damage. Characterized by being "field-applied," as opposed to applied in an OEM factory setting, many are marketed as permanent/semi-permanent solutions. However, all must acknowledge that any coating's lifecycle is contingent on operational characteristics, region(s) of flight, time in the air, and maintenance frequency.

Resin-based paint systems, like the ubiquitous clear coat, are favored for color retention and enhanced gloss, but there are issues with the weight mil thickness can add. While topcoat technology is improving with an exterior base coat - clear-coat system that speeds application and lessens weight, it requires the investment of a full repaint for older planes.

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Proliferation of Advanced Materials

Scrutinizes Process and Technique

Modern manufacturing is challenged by the variety of advanced materials blueprinted into the optic applications that produce smartphones, wearable technology, consumer electronics, advanced defense systems, clean energy, and LED-based lighting, among others. The ultra-hard materials many of these products necessitate (e.g. Silicon Carbide, Gallium Nitride, Diamond, Sapphire, etc.) require innovative processing and finishing techniques to achieve any of a number of specific characteristics intrinsic to the end product. The ability to manage the application process to specification with faster delivery and within a shorter duration, is a sure win/win. It continues to motivate many optics manufacturers to review process, consumables, and equipment.

On the process front, chemical mechanical polish-

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Inquiring minds want to know...

IS PURITY THE SECRET TO IMPROVING POLISHING RESULTS?

An often asked question is whether the purity of the polishing powder makes a difference in polishing results? Higher purity generally translates to higher cost. So, it's no wonder there's interest in knowing whether higher purity powders are necessary to obtain better polishing results.

An optical technician is frequently looking to optimize surface finish, flatness, and material removal rate, all within the same application. Since each output responds differently to changes in consumables and processing variables, optimizing all at the same time is challenging, but not necessarily impossible with compromise and prioritization.

Many optical technicians have used higher purity polishing products (≥98% purity) with improved results. Since the polishing powder/slurry is the significant input variable, the belief that higher purity provides better polishing results, may seem reasonable. However, there are other fundamental properties in the process to consider.

First, let's look at calcination. For standard purity, many abrasive products are made by fusion or calcination of inexpensive raw materials. For example, brown fused alumina is produced by the fusion of bauxite along with additives to make a hard, durable abrasive that is crushed into various sizes. This process is inexpensive and yields a lower purity powder (~80-85%) that is useful for grinding and lapping applications. Another example is standard purity ceria powders (~60-70%) produced by the calcination of mixed rare earth raw materials. To obtain higher purity powders, the most common process is thermal decomposition of chemical precursors, like sulfates, oxalates, hydroxides, acetates, carbonates or alkoxides. The preparation of these intermediate precursors is necessary to separate and derive higher purity powders from natural mineral products. Additional chemical processing steps increase cost to powders, which may or may not score improved polishing results. After extensive testing, two key factors emerge: the results of a powder's polishing effectiveness are inextricably linked to the precursor's chemical manufacturing process and its purity. Further testing with similar purity powders (~99%) show that efficiency of process is strongly influenced by the chosen manufacturing technique such as calcination, fusion or flame pyrolysis. The manufacturing technique will determine phase and crystallinity of the final powder, which strongly affects polishing efficiency in terms of removal rate and polished surface quality.

The choice of the precursor chemical is also very important. Many of the powders that are used for polishing were developed for other applications. For example, many high purity alumina powders were developed as the raw materials for sapphire crystals or precision ceramics. Depending on the application and cost requirements, manufacturers of high purity alumina derive the powders from different chemical precursors to give the powder different final properties. A high purity alumina (99.99%) powder that is derived from a sulfate precursor will have different kinetics and properties than similar purity powder that is derived from an alkoxide or hydroxide. For polishing applications, different chemical precursors will yield similar purity powders, but with different particle morphologies, particle size distributions, friability, surface chemistry, and other properties that influence polishing results.

In conclusion, polishing results are driven by the manufacturing technique and chemical precursor rather than the purity of the powder. A notable exception is when the substrate being polished (or the slurry formula) is affected by chemical impurities, and powders and slurry need to be high purity to avoid any undesirable chemical interactions. To optimize process and minimize cost, you will need to choose the correct abrasive powder that is derived from the appropriate chemical precursor and manufacturing technique.

Advanced Materials:

Affecting Application Processes

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ing, CMP, is finding greater popularity in the optics industry particularly in the service of ultra-hard materials. Linked to the semiconductor industry, CMP's effective planarization process evolved semiconductor fabrication up to twelve layers. Today, its objectives of material removal and surface flatness are put to task on a variety of materials including metals, polymers, glass, hard materials, and composites. A dual technology process, CMP utilizes a chemical formulation specifically targeting the hard/tough material to be removed and hydrating the surface, while the compound's particles or abrasives action planarization. The process is augmented with force and rotating machine action. This complimentary process repeats itself to improve removal rates and attain flat, smooth surfaces. Multiple lapping steps, generally required for hard materials, can be avoided. Innovative processing compounds like **HASTILITE HRD,** *NanoDiamond Lapping Slurry,* are specially engineered for ultra-hard optics. Its unique formulation synergistically combines chemical mechanical properties to enhance removal rates, while simultaneously smoothing surfaces with significantly smaller flaw size, and ultimately, shorter final polishing cycles. Implementing a robust and repeatable CMP process for ultra-hard materials requires optimizing and monitoring parameter processes. The choice of consumables including polishing/lapping slurry, its functional additives and abrasive size distribution, pad and pad conditioning process, and equipment, are critical to process performance and yield.

UNIVERSAL PHOTONICS develops and manufactures slurries for CMP processes for many optical materials and will show you how dual technology can assist your lapping/polishing application.

AVIATION: *Special Purpose Coatings*

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Ceramic coatings are increasingly popular for their longevity. Generally based on a formula of specialized polymers fortified with other chemicals, ceramic coatings deposit a hard protective barrier that has greater resistance to marring and scratching. These coatings produce a super high gloss finish to create a low friction surface reducing parasitic drag.

The hype over Paint Protection Film (PPF), is its chemical composition, which allows most bangs, dings, and scratches to be absorbed. Originally developed to minimize damage to helicopter rotor blades during the Vietnam War, PPF, a polyurethane film thicker than ceramic, claims self-healing properties to prevent swirl marks and hard water spots. As with ceramic coatings, PPF is not an easy application. It requires trained and certified professionals, as well as an ongoing maintenance schedule.

Some may consider sealants outside the special purpose coatings category, but these chemical-based compounds interface with substrate topography forming a hydrophobic film and establishing a protective shield against UV degradation, albeit in shorter life cycles. Engineered to enhance surface color and high gloss retention, a quality sealant imparts added clean-ability, repelling the bugs, stains and soil that cause surface erosion. Sacrificial by nature, they add no weight and require no maintenance. This group is favored for ease of application, which can be performed almost anywhere, at any time. Reapplication requires no stripping, sanding, or peeling.

Interestingly, the drivers for special purpose exterior coatings are advancing unique combinations and match ups. Paint Protected Film, PPF, is applied to clear-coat on painted surfaces for greater resistance to runway rocks, and damage from hail and foreign objects. Variations on ceramic formulas are paired with PPF to slow down the etching process of environmental contaminants. Chemical sealants, like **NUVITE's NuGlaze** *Paint Sealant & Polish* and **NuImage** *Cleaner & Debugger for Polished Metal*, are very often relied on to maintain levels of protection for clear coat, ceramic, paint protected film, and other special purpose exterior coatings.

For assistance navigating the world of aftermarket coatings, and the best way to protect your asset, contact a **NUVITE** field applications engineer.

Rare Earth Processing Key to U.S. Defense

In an effort to secure the domestic supply of rare earth minerals, the U.S. Army announced plans for funding construction of refining facilities to be run by commercial enterprises. Rare earth minerals, and more specifically the heavy rare earths, are critical for weaponry and electronics. Reliance on other countries for these strategic minerals could hamper U.S. defenses. China accounts for 90% of the global supply of rare earth and continues to take steps to secure control of the market, stockpiling and holding reserves.

Late last year a variety of private companies submitted proposals for consideration. According to industry executives, estimated cost for a pilot processing plant could run $20 million, with a full-scale version costing more than $100 million. The Army has agreed to fund up to two thirds of the cost and commits to at least one such facility.

This program will be the first financial investment by the U.S. military into commercial-scale rare earths production since World War II's Manhattan Project built the first atomic bomb.

UPI SPOTLIGHT

CHALLENGE, SUCCESS, POSSIBILITY

You could argue that Makoto "Mike" Kozuma built an illustrious career in precision optics by being in the right place at the right time, but that's only part of the story. Beginning over fifty years ago, Mike was charged with growing the east/west merger of two family-run companies into a global leader, developing, manufacturing, and marketing capital equipment and machinery for the precision optics industry. An ardent believer of not limiting your challenges, but challenging your limits, Mike went into action and for the next thirty plus years continually improved and refined the machining process to meet customer needs, offsetting higher costs with increased yield and lower per piece price. **SpeedFam-IPEC** went public in 1995 as the manufacturer of choice for lapping and polishing machinery for the thin film memory disk, semiconductor and optics industries. Mike was at the helm as global CEO, President, and Vice Chairman.

In 1999, Mike again picked up the gauntlet to join **UNIVERSAL PHOTONICS INCORPORATED®** and focus on its polishing pad manufacturing subsidiary, **JH RHODES® COMPANY**, and the expansion of the company's Far East footprint. As president of these enterprises, Mike works closely with UPI executives, standing on the company mantra "leadership, teamwork, and collaboration" to bridge east/west differences in culture and business styles. Today UPI's five sales and service centers in Japan, China, Hong Kong, Korea, and Taiwan, maintain a leading market share and are well-positioned for future growth.

At JH Rhodes Mike strengthened the 75,000 sq. ft. manufacturing facility with ISO 9001:2015 certification and established a top quality team of engineers and production staff to meet opportunity head on. When cover glass sales were ramping up in 2010, JH Rhodes was tapped to produce and ship a huge order on a near-impossible timeline. Orchestrating raw material procurement, round-the-clock production, and speedy delivery, without sacrificing an ounce of quality, not only increased business threefold, but also secured JH Rhodes position as a world-leading pad manufacturer.

While Mike will tell you that polishing has changed little in 2000 years, he'll quickly underscore that what is being polished demands new and different approaches. For example, applications like smartphone cover glass rely on dual polishing technology. Fortunately, UPI's expertise in the chemical and mechanical polishing process continues to deliver market-leading products.

The precision optics market is always scouting for an edge to increase yield and quality, while reducing time and cost. Mike's "be your own biggest competitor" approach to manufacturing, regularly evaluates opportunities for innovation along with processes to streamline. And while this is a hallmark of his success in a highly competitive market, Mike will point out that sometimes it's just about being in the right place at the right time.