Healthier Humidification

Hospital gases (oxygen, air, and custom combinations of gases) are necessarily cold and very dry, while the body requires them as close as possible to 37°C and 100% relative humidity, if it is not to be stressed due to the need to heat and humidify them inside the lungs. The **Hydrate G**, a medical oxygen humidifier for use in hospitals to deliver controllable, fully warmed and humidified gas to patients with respiratory problems, addresses this fundamental problem in medical care.

Developed by researchers at PARI Innovative Manufacturers, Inc., Midlothian, Va., Sunrise Labs, Inc., Auburn, N.H., Farm Design, Inc., Hollis, N.H., and Vapore Inc., Alameda, Calif., Hydrate G uses a non-obtrusive nasal cannula instead of a facemask to reduce patient discomfort and noncompliance. To meet the respiratory needs of individual patients, Hydrate G permits the clinician to vary the oxygen delivery rate, the relative humidity, and temperature over a wide range. It accomplishes gas heating and humidification by blending high quality molecular water vapor with incoming gases just prior to delivery to the patient. Hydrate G offers increased performance, greater comfort, easier and more reliable operation by busy staff, and a reduced risk of infection over conventional gas delivery systems, all at a reasonable cost.

PARI Innovative Manufacturers, Inc., www.pari.com

A Little Goes a Long Way

Adding lithium to aluminum is a well-known way to reduce its density and increase its stiffness. Alcoa Inc., Alcoa Center, Pa., has mastered a technique for making **Aluminum alloy 2099 extruded shapes (T83 and T8E67 tempers) and plate (T8E77 temper) products,** removing anisotropic properties, poor thermal stability, and low shear strength. Containing up to 5% lithium and several metals including magnesium and copper, the alloy's crystalline structure is altered during the manufacturing process, giving up to 7% lower density and 13% higher modulus than competing aluminum extrusions and plates, saving about 10% in structural weight. Stress corrosion cracks are also mitigated with 2099 alloy, which features 80% slower rates of crack growth.

Alcoa Inc., www.alcoa.com

Nanotextiles Sew Up Conductivity

Among the potential uses for electrostatic self-assembly (ESA) are electronic textiles, which could serve as mobile sensor platforms, electromagnetic shields, and mobile power sources. NanoSonic Inc., Blacksburg, Va., in conjunction with NASA Langley Research Center, Hampton, Va., and NASA Johnson Space Center, Exploration Medical Capability, Space Medicine Division, Houston, Texas, has successfully captured this functionality with their **Metal Rubber Textiles.**

Metal Rubber Textiles are ultralow-weight, nearly transparent, electrically conductive, flexible fabrics. By applying a chemical release layer to the surface of a substrate prior to the self-assembly of thicker materials, metal rubber films may be formed and then chemically released from the substrate.

Metal Rubber Textiles are light and highly conductive, with bulk resistivity down to 10^{-5} Ω-cm. The material can withstand extreme elongations with cracking or spalling and endure thousands of flex cycles with low mechanical hysteresis. A modified ESA approach speeds up the molecule-by-molecule fabrication process, yielding film at a rate of millimeters of thickness/hour of synthesis time. The production technique has low environmental impact, and NanoSonic can create sheets nearly 5 m^2 in size.

NanoSonic Inc., www.nanosonic.com

Kitchen in a Carton

Something as simple as a warm meal can greatly improve the morale and quality of life of military personnel. Formerly, the Army's view of field feeding involved heavy, cumbersome, costly, and largely ineffective methods. However, the U.S. Army Natick Soldier Research, Development, and Engineering Center (NSRDEC), Mass., together with The Wornick Co., Cincinnati, Ohio; TrueTech Inc., Riverhead, N.Y.; Trans Form Plastics Corp., Danvers, Mass.; Heritage Packaging, Fairport, N.Y.; and Southern Imperial, Rockford, Ill., have devised an innovative way to provide a hot meal to military in the field.

The **Unitized Group Ration-Express (UGR-E)**, also known as a kitchen-in-a-carton, is a modular, compact, self-contained unit that automatically heats shelf-stable group-sized meals for up to 18 people, independent of field kitchens, cooks, fuel, and power.

Activating the meal is as easy as pulling a tab, which in one step delivers an activator to the chemical heaters that initiate the exothermic chemical reaction. In just 30-45 min, a meal can be served in trays like a cook-prepared meal. The UGR-E has a minimum shelf life of 18 months at 27°C.

Because it is self-contained and requires no traditional field feeding system, the UGR-E eliminates the need for force protection and sanitation centers, thus saving an estimated 5 gallons of fuel per remote group per meal period.

U.S. Army Natick Soldier Research, Development, and Engineering Center, www.natick.army.mil

Invisible Nanotubes Lead the Charge on Conductor Design

Ultra-thin and optically transparent, conductors are the technological heart of commercially popular liquid crystal displays, solar cells, and touch screens. Successful growth of this billion-dollar industry will require innovative new methodologies to overcome the limitations of the current material of choice: indium tin oxide (ITO).

Eikos Inc., Franklin, Mass., bills its **Invisicon carbon nanotube transparent conductors** as the only viable alternative to ITO, which is batch-produced using expensive materials and high-pressure vacuum methods. Developed by Paul Glatkowski, Invisicon is built using a wet-applied carbon nanotube dispersion in a manufacturing-friendly water and alcohol solvent system. The use of single-wall carbon nanotubes (SWCNTs) is desirable because they combine high conductivity, elasticity, and durability with very low optical absorbance of light. In conductivity alone, Invisicon offers an improvement of at least a factor of ten over sputtered ITO.

By controlling purification and dispersion, then forming a conductive network in such a way that the substrate surface is left open to infiltration by solvents and gases, researchers were able to overcome purity and dispersion problems inherent in SWCNT production. Intended for licensed manufacture of solar cells, flat panel displays, and other optoelectronic products, Invisicon is suitable for ambient condition roll-to-roll processing and may be applied using slot die, gravure, and ink jet methods.

Eikos Inc., www.eikos.com

Polyols Go Bio

More than 3 billion pounds of petroleum-based polyols are required for the production of foams, coatings, and adhesives in the U.S. As crude oil prices rise, so do the prices of petroleum polyols.

Weaning industry off of an oil-based production model for these materials requires practical and cost-effective conversion schemes for alternatives like soybean oil and glycerin. In response, Battelle Memorial Institute, Columbus, Ohio, in conjunction with the Ohio Soybean Council, Columbus, has developed **Reactive Bio-polyols** to fully replace petroleum equivalents.

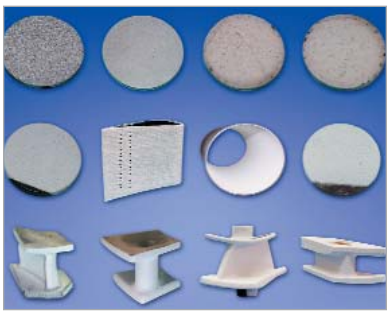
To achieve useful bio-based polyols, an appropriate number of primary hydroxyl groups—desirable for their high reactivity—and secondary hydroxyl groups must be generated from organic raw materials. The key for researchers was to use ozone to rapidly cleave the double bonds of vegetable oils while generating ester polyols at each original double-bond carbon atom.

Their process yielded two polyol varieties notable for low viscosities, an absence of odor and color, and reliance on low-cost glycerin. In addition, they are created with less energy and lower carbon emissions than petroleum-based methods.

Techniques for creating polyurethane products from these polyols have also been researched, and applications include rigid foams for insulation in construction and low- or zero-vapor-emitting coatings for transportation, appliances, and maintenance.

Battelle Memorial Institute, www.battelle.org

Nano-Coating Locks Out Heat, Water



Intent on improving gas turbine engine efficiency, NASA Glenn Research Center, Cleveland, Ohio, has introduced a new coating approach for creating **Defect clustering thermal and environmental barrier coatings (TEBCs) for Si-Based Ceramic Turbine Engine Components** that allow engines to operate at temperatures up to 333°C higher than other barrier technologies. That includes advanced barium-strontium-aluminosilicate environmental coatings and zirconia-yttria thermal coatings. TEBCs consist of four parts. The top layer incorporates a novel defect cluster oxide base that features thermodynamically stable interfaces. Phonon scattering at the nanoscale inhibits thermal radiation, resulting in conductivity rates less than half of other coatings. The other layers include a strain tolerant interlayer, a mullite/rare-earth silicate environmental barrier layer, and an advanced ceramic oxide/mullite bond coat layer. In addition to being highly resistant to water-based corrosion, TEBCs also show significant gains in sand particle and velocity gas erosion resistance.

NASA Glenn Research Center, www.grc.nasa.gov

New Foam Has Crushing Advantage

A combination of lightweight materials and computer-assisted designs has given modern automobiles impact-absorbing body structures that transmit energies throughout the vehicle body, protecting occupants from harm.

Advanced foam technologies hold the promise of improving these crash protection systems further still. Dow Automotive, Auburn Hills, Mich., has introduced **IMPAXX Energy Absorbing Foam**, an easy-to-make lightweight material which can absorb up to 130% more energy than other foam types, including expanded polypropylene beads and polyurethane.

Researchers have done this with a manufacturing process that gives the foam physical properties that vary depending on the direction of measurement. Made from a styrenic thermosplastic mixed with other additives, IMPAXX retains its greatest strength with an alignment in the vertical or thickness direction of the application. Energy-absorbing parts can be designed and fabricated with the thickness of the part aligned in the vertical direction of the foam plank. The foam bears the brunt of the collision.

In addition to weight-saving advantages of up to 60% over other foams, IMPAXX is recyclable, and the blowing agent is free of harmful hydrofluorocarbons. The new material also boasts an advantageous cost model. Tooling modifications are not required for manufacture, and prototype parts directly reflect product performance.

Dow Automotive, www.dow.com

Eliminating Hot Roll Blisters

Heat treating plate and pipe steel involves temperatures of up to 954°C, a level that exposes furnace rolls to severe swings in temperature and moisture. This punishment causes blistering oxidation of conventional austenitic stainless steel, resulting in harmful scratches on production stock.

To combat this problem, Duraloy Technologies Inc., Scottsdale, Pa., has created **Cast Nickel Aluminide (IC-221M) for Improved Productivity of Steel Heat-Treating Furnaces (ASTM Grade A 1002-99)**. Developed in conjunction with Oak Ridge National Laboratory, Tenn., consultant Anthony Martocci, Bethlehem, Pa., and Mittal Steel USA, Chesterton, Ind., IC-221M has nearly 5x the yield strength and nearly 1.5x the creep rupture strength of current stainless steels used in furnace rolls. It is also resistive to oxidation damage.

IC-221M accomplishes this performance with an intermetallic ordered crystal structure—nickel aluminide. The metal has been successfully tested at several sites, having already saved 124 billion BTUs of natural gas over four years at a test plant.

Duraloy Technologies Inc., www.duraloy.com

Basic Coal Yields Tough Foam

Carbon composites are typically based on graphite, which requires time-consuming and expensive processing. Researchers at Touchstone Research Laboratory Ltd., Triadelphia, W.V., have offered an alternative to graphite with **CSTONE**, carbon foam made from conventional coal that has a higher strength-per-unit density than graphite. A high-density porous material, CSTONE has a wealth of advantageous properties: excellent electrical conductivity, good thermal shock resistance, high mechanical strength, low coefficients of thermal expansion and friction, superb chemical resistance, low thermal conductivity, and high hardness.

If protected from oxidation, CSTONE's mechanical properties do not deteriorate with increased temperatures, and it can be bonded with other materials, such as metals. It is also suitable for high-temperature, ablative-resistant applications.

Touchstone Research Laboratory Ltd., www.trl.com

Hardening Steel

Overlay materials used in welding are usually macrocomposites developed from hard particles such as carbides or nitrides. A binder, typically nickel-, cobalt- or iron-based, is needed to hold the hard materials together during use and provide toughness and crack resistance. Until now, the king of high-wear applications has been tungsten carbide (WC), a pricey material which is much more abrasion-resistant than conventional steel plate. However, researchers at The NanoSteel Co. Inc., Idaho Falls, Idaho, have offered an alternative with **Hardmetal Alternative Technology SHS 9192 Welding Wire,** a glass-forming steel that does not need a binder. It is made using nanoscale microstructures formed using a solid-state processing method called glass devitrification.

SHS 9192 is a blend of 10 elements featuring low critical cooling rates for metallic glass formation. High undercooling achieved prior to nucleation and growth results in a marked refinement of microstructure over conventional alloys. The advantage is volume loss reduction by a factor of two or more in both single- and double-pass applications over carbide wires. Because SHS 9192 is predominantly iron, it also offers price advantages and has been developed for both gas-shielded and open arc applications.

The NanoSteel Co., Inc., www.nanosteelco.com

Titanic Savings in Titanium Production

Titanium is well known for having the greatest strength-to-density ratio of any metal. However, titanium manufacturing costs have proven difficult to keep down. Researchers at International Titanium Powder Inc., Lockport, Ill. have accomplished that goal with **ITP, Armstrong Process CP Ti and Ti Alloy Powder and Products**. Developed with researchers from Oak Ridge National Laboratory, Tenn., BAE Systems, Santa Clara, Calif., AMETEK, Wallingford, Conn., National Energy Technology Laboratory, Albany, Ore., Red Devil Brakes, Mt. Pleasant, Pa., and the U.S. Army Research Laboratory, Adelphi, Md. ITP processes eliminate several time-consuming and expensive processing steps in the production of titanium plate.

In the Armstrong Process, a titanium tetrachloride vapor is injected into a continuous stream of molten sodium. A reaction produces titanium powder and sodium chloride. This method allows any element that can be made into a halide to be reduced with titanium to create alloys. The advantages are considerable across the board. Armstrong titanium powder is cheaper than conventional equivalents by up to 93% for powder, 50% for ingots, and 50-85% for plates and sheets.

The procedure has the added advantage of operating continuously at low temperatures, yielding fewer contaminants. Plus, components can be made to shape with less scrap waste.

International Titanium Powder Inc., www.itponline.com