Basic Materials

The Basic Materials category outlines technology in coatings, chemicals, or ingredients that improve durability and longevity; composite materials; advanced multipurpose materials; and structural or strength materials. These technologies, many of which originated at basic research levels in universities or national labs, hold promise for a variety of construction applications.

Technology Scanning

One of PATH's major research support services is PATH Technology Scanning. *Technology Scanning* tells us about technology developments in other industries, from other nations, from federal laboratories, and from other building sectors. PATH looks for breakthroughs in other industries that could be transferred and applied to housing. *Technology Scanning*—published by the U.S. Department of Housing and Urban Development/PATH and prepared by the NAHB Research Center, Inc.—are updated as technology developments dictate. The Research Center works to unite technology developers from outside of residential construction with manufacturers in the residential housing sector.

This issue of *Technology Scanning* is one in a series. Each issue in the series falls into one of the following categories:

- *Design and Internet Tools*
- *Safety*
- *Surfaces and Interior Finishes*
- *Building Envelope Technologies*
- *Electrical*
- *Plumbing*
- *Heating, Ventilating and Air Conditioning*
- *Energy/Power Systems Generation*
- *Basic Materials*
- *Information Technology*
- *Sustainable Design Strategies*
- *Materials Recycling and Reuse*
- *Thermal and Moisture Protection*
- *Indoor Environmental Quality*

Call the ToolBase Hotline at 800-898-2842 for information about other available *Technology Scanning* issues. Or, log onto pathnet.org and www.toolbase.org.

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Coatings, Chemicals, and Ingredient Materials

These material technologies have been developed by large global materials research companies to be sold into a number of applications such as coatings, chemical additives, and ingredients. They have specific engineered properties that when combined with other materials, provide a desired engineered outcome.

DuPont Tefzel

This ingredient material is engineered to have durable, wear-resistant characteristics. It is used today as a protective coating for Uni-Solar shingles and standing-seam metal roofing. The roofing products are wear-resistant, durable, and weatherable. This ingredient material has other potential applications in construction products, where the desired outcome is durability and wear resistance (siding, decking, flooring, and other surface products).

Contact:
DuPont
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www.dupont.com/teflon/films/next-gen.html

DuPont ImRon Coating

This DuPont coating comes from a history of coating innovation. It is touted to out-weather other industrial paints. It has superior abrasion resistance. Currently, it's used in heavy equipment manufacturing for equipment that sees harsh conditions on a daily basis. It has significantly reduced maintenance costs for those users of heavy equipment. Applications in housing could include paints and stains, along with coatings on a variety of exterior components.

Contact:
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www.dupont.com/finishes/na/000401.html

Self-Placing Concrete (MelFlow)

This formulation of ingredients for concrete reduces the amount of water used, optimizes water/cement ratio, increases strength and durability, and reduces mixing time by 30 to 40 percent. It is self-compatible and self-consolidating. It requires no tamping or vibrating, and it provides density without segregation. It is being developed for the Korean and Asian building industries.

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www.new-technologies.org/ECT/Civil/flowconc.htm

Highly Durable, Environmentally Friendly Paint

The Army Research Lab (ARL) has patented coating technology available for transfer that is highly weatherable and durable. It is flexible at ambient and subzero temperatures, mar-resistant, and corrosion chemical agent resistant. This water-dispersible coating can be applied with standard spray equipment and low VOCs. The technology may have paint and finish applications in the housing industry.

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Issue 1
November 2001

Durable, Tough, No-Slip Coating

From the after-market and OEM truck industry, bed liner material, which is applied by spray or roller, can be looked at for a weatherable, durable, and slip-resistant surface for almost any substrate. TUFF STUFF, one brand of coating, can be applied to almost any metal, wood, or concrete surface. One can create various textures and colors with additives. It has been proven for 15 years in the truck bed liner market. This coating could have application in roofing for homes or other coatings needing weatherable, durable properties. If applied in roofing, it could speed up the time to finish a roof and be a safer means to finish the roof for the worker.

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www.rhinolinings.com

Concrete Corrosion Solutions

This technology uses electrical treatment combined with a chemical process to fight destruction of concrete structures from salt air, moisture, and baking sun. It was developed by NASA's Kennedy Space Center research scientists for the protection of all of NASA's concrete structures, buildings, and miles of runways and launch pads in Florida, the Texas Gulf, and Alabama. The process, called electromigration, sends corrosion-inhibiting ions to the rebar or steel within a slab or structure. Surtreat's proprietary chemical protection is applied to the surface and seeps into the concrete to the rebar to prevent further corrosion. It corrects the chemical imbalance that can cause the rebar to corrode.

Concrete loses its pH or acidity level over time. New poured concrete has values of 11,12, or 13, and these high values help to inhibit corrosion. As concrete naturally ages and is exposed to more UV, the pH values drop. When it reach levels in the 8-9 range, concrete becomes susceptible to quicker deterioration. That's why bridges, buildings, roadways, driveways, patios, and sidewalks deteriorate more rapidly after they reach a certain age. NASA anticipates saving significant time and money over traditional repair methods that are shorter lived.

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Composites and Coatings Consortium

This group has developed Advanced Coating deposition technology that can efficiently deposit thin films or sputter coats of durable coatings on a variety of materials. This consortium has also developed affordable, high-wear, high heat-resistant ceramic composites.

Contact:
Great Lakes Industrial Technology Center
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Cleveland, OH
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Moisture-Resistant Coatings

This NASA-developed coating for ceramics makes the coatings 1,000 times more durable. The moisture-resistant coating made from specially treated boron nitride extends the shelf life of composite materials. It can also be applied by chemical vapor deposition to many substrates where durability and protection from heat, moisture, and other elements are desirable. The process and coating, developed for NASA by Advanced Ceramics Corp, Cleveland, OH, opens up new opportunities for more durable materials and composites in all industries.

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New Acrylic Roof Coating

Vanberg Coatings, introduced to the dairy industry, is a new acrylic roof coating that is a monolithic membrane providing a durable, water-tight surface over concrete, wood, or metal roofs. It withstands UV light, temperature extremes, mildew, etc.

Contact:
Vanberg Coatings
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www.vanbergcoatings.com

Durable New Metal Coating

Cleary Building Corp, Verona, WI, introduced a breakthrough in painted metal panels to the dairy industry for metal outbuildings. Alurite 2000Plus coating system is a durable enhancement which allows for a 35-year warranty on painted metal panels for roofs, sidewalls, etc.—an industry first. This coating could be looked at for other building component durability enhancements in residential building products.

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Cleary Building Corporation
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www.Clearybuilding.com

Biocide Coating Additives

This coating additive controls mold or mildew cost effectively for interior or exterior coatings. Mergal S90 is formulated for roofing products, sealants, and architectural coatings. Troy biocides are environmentally sound, durable, and long lasting.

Contact:
Troy Corp.,
Florham Park,NJ
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www.troycorp.com

Duration High-Performance Exterior Coating

Sherwin-Williams, in addition to showing its low odor paints launched last year, exhibited another new coating at the International Coatings 2001 Expo, called Duration high performance exterior coating. The company offers a lifetime warranty for a single coat properly applied on exterior walls. This coating is based on modified acrylic that adheres well, is flexible, and protects against cracks and chips.

Another brand new development launched this year makes coatings that dry on substrates as cool as 35 degrees Farenheit, which extends the painting season well into the fall and winter months in many parts of the country.

Contact:
Sherwin-Williams
www.sherwin-williams.com/dig/newsolutions/duration.asp

Composite/Fiber Structural Materials and Applications

Composite material and process technologies are among the fastest growing new material applications. Composites are combinations of materials and resins that orient fibers, mats, or matrix structures in the desired area and direction to take advantage of their individual properties. Composites are usually stronger and lighter in weight than the materials they replace. Currently the automotive industry is the biggest user of new applications. The construction industry is emerging as the next big target for the composites industry. As applications expand, processes improve for volume applications, and the volume of composites increase. The raw materials and finished part costs will continue their downward trend. New configurations and materials are also emerging, namely ceramics and carbon fiber technology.

Affordable Fiber-Reinforced Ceramic Composites

This consortium has developed affordable, high-wear, high heat-resistant ceramic composites. Developed for the defense and aerospace industries, these technologies are finding their way into many civilian applications through the federal government's Technology Transfer Centers.

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Owens Corning Composite Systems

At the Composites 2001 Show, Owens Corning displayed its latest venture with a tier-one automotive supplier—a complete composite truck bed assembly for Ford. It incorporates a composite bed, fenders, and sidewalls in one component ready to assemble to a truck frame. It eliminated multiple metal and steel components; it increased durability; it reduced weight; and it improved fuel efficiency. This is a good example of systems integration. Owens Corning, a current building industry supplier, could explore this approach for components in houses (i.e., walls, floors, roof panels), taking more of a component/systems approach vs. parts and pieces.

Contact:
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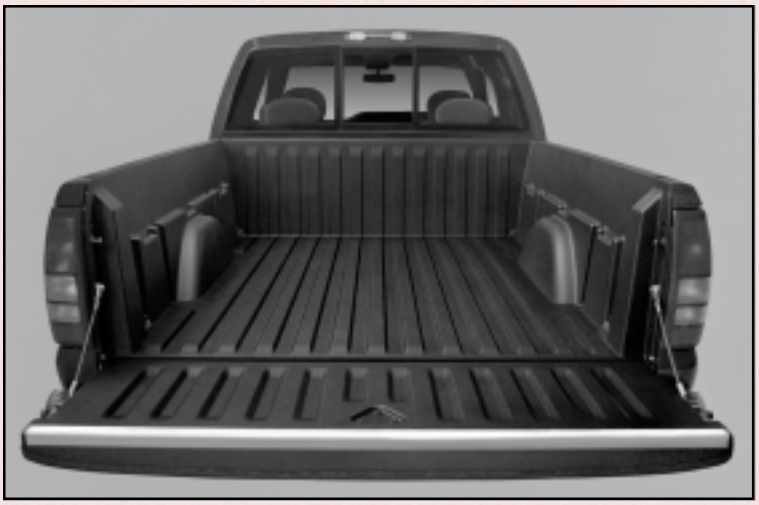

Owens Corning complete composite truck bed incorporates a composite bed, fenders, and sidewalls in one component ready to assemble to a truck frame.

Courtesy: Owens Corning

Plastic Silica Composite Tougher than FRP

Ohio State University scientists have patented a method of mixing plastic with silica to create a heat-resistant material five times more impact resistant than fiber reinforced plastic (FRP). The patented manufacturing process forces melted plastic into the pores of silica, thereby creating a stronger bond. It can be used as a lightweight substitute for iron, steel, or aluminum. The process was first developed for making tough plastic dental fillings for the medical industry.

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ParaBeam 3D Glass Fabrics

At the Composites 2001 Show, a Dutch firm demonstrated cutting-edge technology to make impregnated, lightweight sandwich panels and skins from glass fabrics. Panels or skins are an ideal basis for easy finishing with other laminates or foils. Foam cores can be integrated for thermal purposes. Properties include lightweight, excellent strength and stiffness, full service adhesive properties, easy reparability, and corrosion and water-resistance. Applications in Europe include storage tank walls, high-speed watercraft skins, truck and cargo floors, train and bus exteriors, building cladding, and interior partitions. Ideal applications in the housing industry could include building panels and skins, and floor and roof panels.

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www.composite.about.com/library/PR/2001/blparabeam1.htm

Reinforced Cores at Lower Costs

Webcore Technologies of Dayton, Ohio, claim their Tycor fiber-reinforced foam cores are a low-cost solution for composite sandwich. The process uses glass or carbon fibers to build a 3D web and lattice structure within low-density foam. Both skin faces are mechanically stitched together through the core. The fiber structure allows for quick resin flow and uniform wet-out. Cores and panels are being developed for commercial industries (aviation, marine, truck, and civil engineering). Applications in construction could include building panels, and structural components that combine thermal, structural, and surface properties in one composite sandwich instead of individual parts.

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www.compositecenter.org/press4_content.stm

Composolite FRP Panels

This is a new lightweight, high strength, glass fiber reinforced polymer modular construction system. Used extensively in Europe for over 10 years, it is produced by Strongwell in the U.S. Applications for housing include wall panels, floor decking, and roof decking.

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www.strongwell.com/PULT/pultrusion.htm

Tougher Fiber/Cement Composites

This is a process technology to increase bond strength and interface toughness of synthetic fibers. It is used in reinforcing cement-based composites. Application allows tailoring interface properties of a given system to produce cost effective, high performance, fiber-reinforced, cement-based composites (Patent issued) (File #1193). The material, called Torex, optimizes geometry of fiber reinforcement in cement, ceramics, and polymeric composites for lower cost (Patent issued) (File #1063).

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Low Weight Composite Sandwich Promises High Strength

Moldite Technologies has developed a pultrudable reinforced plastic that can rival steel and aluminum in strength and stiffness at a tenth of the weight. Other benefits include impact resistance, mildew resistance, and fire resistance. Dave Peash, Chief Executive, sees potential applications in the automotive, marine, aerospace, and construction industries. Currently, they are testing the material formulation in plastic reusable pallets.

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www.link2semiconductor.com/articles/is032313.jsp

Composite Panel Structural Material

From the civil engineering industry comes a technology called Composite Fiber Reinforced Polymer (FRP) bridge deck. The deck sections are lightweight, highly durable, strong, and rigid. Test bridge installations can be found in Ohio, Virginia, West Virginia, and Pennsylvania. This technology could be applied in wall panels, roof decks, floor, and deck panel systems.

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Space Age Materials on Earth

Transfer of high tech composites technologies from aerospace has always been relatively cost prohibitive. With simpler and more accessible production processes, composites could reach broader markets faster and less expensively.

Quickstep Technologies of Australia has developed an advanced mass production process for high quality composites. They are able to produce fiber reinforced plastics that are cheaper, with higher strength, improved appearance, and reduced cure times. The solution involves an innovative system employing lightweight rigid molds suspended in heat transfer liquids (water or oil). The liquid circulates in a low-pressure environment with a flexible membrane maintaining constant pressure and heat on the mold. The pressure and heat compact the laminate and cure the component, while vibration forces out trapped air and gases. Quickstep has set up a pilot plant to test a mass production scalable effect.

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Lower Cost Structural Substitute

Structural fiber reinforced plastics is a new material technology that could be a substitute for traditional structural materials like steel, concrete, masonry, and wood. It is low weight, high strength, with lower installed costs and lower maintenance costs than traditional structural materials. The technology is being tested in Japan as concrete mesh reinforcement; in highway bridges in Calgary, Canada; in a prototype composite bridge in Russell, Kansas; and in pedestrian bridges in western U.S. National Parks. Upon verification of the benefits and properties, other broader complex applications can be developed and tested.

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Carbon Fiber Mat

This technology creates more opportunity for application of carbon fiber as a structural material in composites. Several companies have now perfected carbon fiber in mat or sheet form as reinforcement in composites, making it much easier to develop products with superior strength, and lighter weight than traditional wood or steel products. Previous carbon fiber forms of strands or fiber length were application specific and limited in what applications could be developed.

This advancement greatly expands the opportunity to use carbon fiber in structural composites and plastics. Here are several of the new materials:

- Fortafil Fibers- Uniweb continuous fibers sheet and IsoWeb random chopped fiber mat;
- OBS, Inc- Produces lightweight carbon fiber yarn fabric for extremely thin, lightweight application;
- Schappe Techniques- 100 percent carbon fiber yarn and multi-axial fabric; and
- Saint-Gobain Technical Fabrics- Bay Mills Carbon Fabrics.

Currently applications have been in leisure and recreational products, industrial products, and aerospace applications. Carbon fiber fabrics and mats could be developed into composite wall systems, roof panels, floor panels to produce high-strength, lightweight, easy-to-handle building panels. Carbon fibers have been added to Glulam beams to increase the load bearing capacity by up to 100 percent.

Contact:
www.fortafil.com
www.sgbti.com (Saint Gobain)
Dedicated search engines at www.wwcomposites.com

Snap Joint Technology for Assembling Composite Structures

Developed for aerospace applications and utility transmission towers, this technology allows composites to be used in many applications with the benefits of less weight, faster assembly, less labor, and less equipment. It is in use on DOT projects and transmission towers in California. It is proposed for assembly of all composite rocket towers at Vandenburg Air Force Base. This technology has won industry awards and has made the job of connecting composite applications simpler.

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Structural Ceramics

University of Pennsylvania, Department of Materials Science and Engineering, is doing work in deformation and fracture of structural materials, chemistry and physics of ceramics, polymeric materials, and electronic materials.

Surfaces and interfaces research includes: metal-ceramic interfaces, polymer-ceramic interfaces, carbon based materials, and inter-metallic alloys. Synthesis and materials processing research provides the discipline that looks at materials (new or modified) to solve a standing industry problem or enable applications of new materials into an industry. Some of the specific projects with potential for construction industry use and application include:

- Structural Ceramics—Professor I-Wei Chen developed two novel ceramic applications, including a ceramic wood combination;
- Molecular Control of Adhesion—Professor Russell Composto; and
- Interface of Structural Materials—Professor David Luzz.

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Innovative Structural Modeling and Simulation

CSIR Boutek, a national agency and research arm in South Africa, aligns R&D with current and future needs in South Africa, bringing the latest technology to bear on applied solutions. Among the materials research is an assessment of new innovative structural applications (modeling and simulation, physical testing), and ceramics use and application in building products.

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Glass Reinforced Plastic Won't Shatter

Glass reinforced plastic flat sheet developed in the UK claims to be able to withstand the most violent of storms. Called Meshlite Starlite, the glass panels can withstand a 50 kg weight dropped from a height of 4m. It is designed to be tougher than glass and lower in price. Its main uses include doors, windows, and skylights. It is currently being tested in nuclear power plant applications where shatter resistance is critical.

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Flexible Glass

The Material Resources Group at the Pacific NW National Laboratory is developing flexible glass for the flat panel display industry. It has the flexibility of plastic and barrier protection approaching that of glass. Roll-up computer screens and other flexible wall displays are possible. The process involves depositing multiple layers of organic and inorganic materials in stacks. The

Courtesy: Pacific Northwest National Laboratory

Scintillating glass optical fibers are the first viable medium for large-area, solid-state, thermal neutron sensors that have applications in national security, medicine, and materials research. Here, ultraviolet-induced fluorescence mimics scintillation.

Flexible Glass, continued

stacking architecture allows each layer to help protect against defects in adjacent layers (10 microns thick).

The results are glass-like clarity, impermeable, and durable, but flexible and a lot like glass. Flexible glass could have application in doors and windows in the future or incorporate the functions of windows and displays into one product. Windows could be simpler, lighter weight, and with fewer parts.

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New Composite Material to Replace Concrete

Ductal® is a new composite building material being developed jointly by several European companies and LaFarge Corp of the U.S. LaFarge Corporation is one of North America's largest suppliers of construction materials like cement, gypsum, roofing, aggregates, and concrete. The new material announced at the World of Concrete2001 is impermeable, non-corrosive, cementitious-like, containing chopped wollastinite and bronze fibers along with mineral fillers.

Carbon fiber can be added and the material adjusted for the different properties required. Ductal® can take any surface texture and can be pigmented for a high quality surface finish. Ductal® is expected to be lighter weight, less labor and machine intensive, and a replacement for conventional concrete structural parts. With strength similar to steel and toughness equal to ceramics, it can outperform steel and concrete. The purported cost savings come from faster construction time generating labor and material savings. Ductal® is pre-mixed and with the addition of water can run through existing concrete batching equipment.

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Advanced "Smart" Materials

A new generation of materials is in the research phase at several national labs and universities. These materials perform multiple functions, can be engineered to change function, and can be embedded with other chip and coating technology to make materials do what we want and when we want on demand to set criteria.

A Plastic that Heals Itself

The Washington Post reports on a self-healing plastic that uses high tech materials and a low-tech concept inspired by the human body. It has been developed for use in repair of car bodies, surfboards, Defense Department applications, pole-vaulting, and cell phones. Work is also being done on embedded sensors in the materials that show weak or wear spots by changing their color, so that the user knows fatigue of the material before it fails and causes harm or injury. Healing is site specific to the area fractured or cracked and is accomplished when new resin is self generated and formed around the fissures or cracks.

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New "Active" Materials

Funded by the Army Research Office, with development at MIT, this technology utilizes electric voltage to direct material change into a desired mechanical response (active fiber composites). Materials with multiple, changeable functions can be engineered to replace many materials with one application. In the building industry, changeable glass is already being tested. Other applications include interior / exterior surfaces that adjust to conditions or can be adjusted to fit pre-desired conditions.

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Material Can Change Functions

Graphite flakes and film, highly reflective and silvery-black, are electrically conductive and can be used wherever appearance and conductive coatings are important (high luster paints, surface coatings, conductive flooring, shielding material) (Tech #129ML).

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