Basic Materials

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

Nano Materials

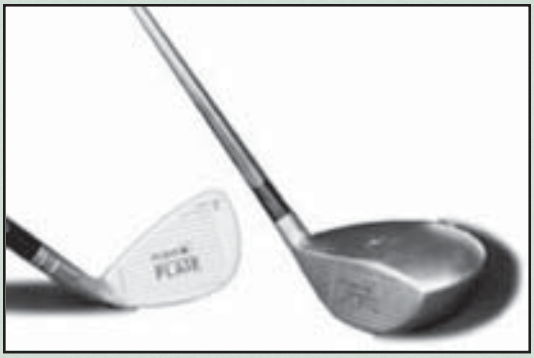
Nano-technology includes a broad range of disciplines where materials or processes are carried out at a very small level, often at the molecular level. It is one of the fastest growing fields in science today with applications related to materials science, solid state electronics and physics, and inorganic chemistry.

Potential applications for housing have already surfaced. Pacific Northwest National Laboratory and Oregon State University are developing revolutionary cooling systems that could be extremely small and lightweight and used as individualized heat pumps for every room of the house.

Nano-Coatings

Nano-coatings are produced by shrinking the material at the molecular level to form a denser product. Many of these materials are produced using a electrodeposition process pioneered through a collaborative effort in Ontario, Canada, and are now being produced commercially. The end result is a material that is stronger and more-durable than in its original form. Reducing the molecular structure improves nearly all of the mechanical properties of the material including yield strength, tensile strength, fatigue strength, and elongation. One downside is that nano-materials can decrease the ductility of the material.

Nano-coatings are typically designed to be applied to steel and other conductive surfaces using electro-plating processes. Still others are applied as a simple spray-on coating, or as powders that are added to composite materials to enhance the physical properties of the base material.



Courtesy: Integran

Nanocrystalline materials and coating with metallic grains up to 1000 times smaller than conventional materials - making them harder, stronger and more wear-resistant.

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Nano-Ceramics

The University of Delaware has a U.S. Army-funded Center for Composite Materials. One of their objectives is to develop nano-ceramic materials. They are working on experimental techniques to develop nano-ceramics for high strain

Technology Scanning

One of PATH's major research support services is 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 Newport Partners LLC-is updated as technology developoments dictate.

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*
- *Heating, Ventilating, and Air Conditioning*
- *Energy/Power Systems Generation*
- *Basic Materials*
- *Information Technology*
- *Thermal and Moisture Protection*
- *Indoor Environmental Quality*

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Nano Materials, continued

conditions. These high-strength materials could be useful in developing advanced building technologies for housing and other uses.

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Nano-Structure Metals and Metallic Glass

The U.S Army Research Laboratory sponsors several Centers of Excellence related to advanced materials. Johns Hopkins University (JHU) is working on high-strength nano-structure metals. With this technology, the structure of a material is denser than traditional forms of the same material. One issue with nano-structure metals is that the higher strength and durability creates low-ductility. JHU is working on lower strain hardening technologies. These high-strength materials could be useful in developing advanced building panel technologies for housing.

JHU is also developing metallic glass composite materials for anti-armor applications. This would result in a material that is impact resistant and has extremely high strength. Possible applications include kitchen and bath fixtures, flooring, or advanced panel products.

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Coatings and Ingredient Materials

Advanced 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 outcome.

Advanced Products Derived from Soybeans

Perhaps the first well-recognized soy product was automobile panels made from soy plastic by Henry Ford in 1933. The United Soybean Board (USB) publishes the *Soy Products Guide: A Listing of Soy Industrial Products*. The most recent version lists seven products that are under development for the building products arena: an ultra-low density, open-celled spray foam designed to insulate commercial and residential buildings; a spray-in-place foam insulation with no harmful emissions; a soybean-based technology that replaces a portion of the system required to make polyurethane carpet backing; a soy-based roofing coating designed to deflect ultraviolet rays; a soy-based stain that makes it possible to add the rustic look of wood to a fiber cement-sided home; a soy-based wood stain without the smell and toxicity issues of traditional stain; and a biocomposite decorative interior material.

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Surface Engineered Polymers

SICOR is a new process that has made it possible to permanently bond, print and paint components made from low-cost environmentally friendly polypropylene and other plastics. The concept involves oxidizing the surface of a polymer followed by the deposition of special types of chemicals (such as silanes and others), which form 'chemical connector' molecules on the surface of the originally 'smooth' and chemically inert plastic. The technology was invented at the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia. This breakthrough means that a new generation of components can now be manufactured from polypropylene. CSIRO has established a spin-off company, Polymer Surface Technology Pty Ltd to commercialize SICOR bonding technology.

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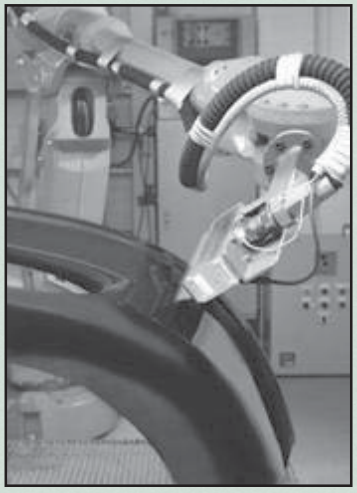
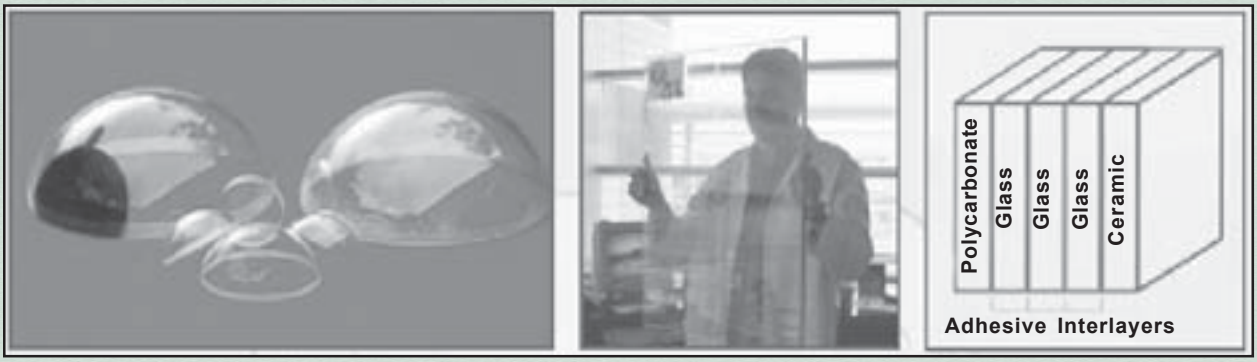
Composite and Structural Materials

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



Courtesy: CSIRO

SICOR bonding technology allows the sticking together of previously unbondable or hard to bond materials.



Courtesy: U.S. Army Research Lab

From left to right: 1) Transparent ceramics for sensor windows 2) Sapphire-based transparent armor prototype 3) Vehicle transparent armor windshield laminate system

biggest user of new applications. The construction industry is emerging as the next big target for the composites industry.

Kevlar Storm Room

DuPont Kevlar® is a silky, soft man-made fiber that is stronger than steel on an equal weight basis, combining great strength with great lightness. Kevlar® is best known for its application in the field of bullet-resistant personal body armor. DuPont recently introduced a "storm room" concept that could use these reinforced fibers in the residential building industry. Application of the Kevlar® reinforcing system to a room will protect it from penetrations due to wind borne debris from a major hurricane or tornado event.

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Transparent Ceramics

Transparent ceramics are being developed by the Army Research Laboratory (ARL) for armor applications. The materials exhibit enhanced thermal and mechanical properties while maintaining clear vision. The Army envisions a wide range of end use applications to include face shields, windshields, and windows.

Ceramics typically are opaque because their trapped pore structure scatters light. Transparent ceramics are manufactured with minimum porosity resulting in transmission of clear images. However, current materials of this type are prohibitively expensive using today's production methods. ARL is investigating development of low-cost transparent ceramic-based materials to replace current soda/lime/silica glass processes and polycarbonate materials. ARL estimates more-advanced single-chrystal and polychrystalline materials will reduce weight of transparent ceramic materials by 30% and thickness by 40%.

ARL's goal is improved protection of soldiers. Thus, the focus is on uses in ground vehicles, soldier protection equipment, and other armor systems that require transparency. However, there are numerous commercial applications for this technology such as glazing in the housing market.

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Plastic and Renewable Fiber Composite Systems

Under the trade mark FLAXOPROP®, a range of products have been developed that combine the use of natural fibers and plastic fibers. By incorporating new technologies, these products use natural renewable resources, such as flax, hemp, sisal, jute or kenaf as reinforcement fibers and binders for recycled man-made fibers like polypropylene. Applications include dividing walls, re-usable temporary shuttering. and interior wall paneling.

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Resin Transfer Molding of Fiber Reinforced Plastics

Whitewater Composites, Ltd is opening up opportunities to expand the use of fiber reinforced plastics through an innovative manufacturing process. Resin transfer molding involves placing fibers into a mold. Then, a thermosetting resin is injected into the mold. This process allows the flexibility to manufacture complex shapes and forms, including curves. It produces products that are strong and lightweight. Typical installations include facades and

Courtesy Photo: General Plastics Manufacturing Co.

R-9300, a polyurethane bearing block, is designed to support heavy structural loads while insulating a building interior from the supporting ground.

Resin Transfer Molding of Fiber Reinforced Plastics, continued

architectural details on commercial buildings, particularly franchises that are repetitively built.

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Polyurethane Bearing Blocks

General Plastics Manufacturing Company produces R-9300 high-density bearing blocks, providing thermal isolation for steel roof columns in refrigerated buildings. This product can also be used to isolate warm structures in very cold environments as well. Made with a high-strength polyurethane, R-9300 blocks provide insulation and structural support at the base of columns, with "R"-values of approximately 2 per inch of thickness. Because the blocks are closed cell, they are resistant to the penetration of water. A range of available densities allows for structural-support loads of up to 1800 psi.

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Unsaturated Polyester Molding Compounds

The manufacture of electrical equipment using unsaturated polyester molding compounds dates to the late 1970s. A range of auto applications for bulk molding compounds emerged in the 1980s with dimensional stabilities at elevated temperatures. They are designed to meet automotive industry requirements for ten year/ 150,000 mile durability. Bulk Molding Compounds have since found niches in electrical and power tool markets, as well as for high-temperature parts for large and small home appliances. With the addition of specific polymers, BMC, Inc. is now gaining acceptance for countertops, sinks, and other housing applications.

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Woven Strapping Materials

Polyester and similar wove materials being produced by CordStrap, LLC, provide a material that is strong, flexible, comes in a roll, and has a wide variety of uses. The main current use of these products is for strapping to bundle building products and other supplies. They are also used for agricultural applications. CordStrap sees other potential uses in homebuilding such as hangers for plumbing or ductwork, or to structurally tie a building together.

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Courtesy: CordStrap, LLC

Polyester strapping material is used to wrap bundles of lumber.