

Disappearing Act

by Blaine Brownell

A fundamental counter-trend in materialism has emerged from a recent surge of interest in new materials for architecture and design—materials are slowly...disappearing. I'm not referring to some science fiction fantasy à la "Invasion of the Material Snatchers", but rather the technological trends leading to increased strength-to-weight ratios and light-transmittance. This tendency toward dematerialization is rooted in the natural trajectory of technology itself—to maximize efficiency, miniaturize, and do more with less—coupled with an intriguing socio-environmental phenomenon of increased transparency in the physical environment. This "de-solidification" reflects both the public desire for increased access and accountability from the outside of commercial and institutional structures and the desire for increased access to light and views from the inside of structures. Looking toward the future, the frontiers of material development are defined by high-performance, exotic materials and composites that shatter previous paradigms about solidity and opacity.

Nanogel

The relationship between the historically solid, insulating wall and the light-transmitting, thermally-conductive window has forever changed with the development of Aerogel and its application in the product Nanogel. Now walls can be windows and vice-versa, and the age-old battle between light vs. thermal protection is rendered moot. Aerogel, a translucent insulating material, is the lightest human-made substance known. Its application in the product Nanogel, developed by Cabot Corporation, is a pelletized, nanoporous material that delivers unsurpassed thermal insulation and light transmission. Comprised of quartz particles mixed with 99 percent air, feather-light Nanogel weighs 90 grams per liter. Compared with other insulation materials, Nanogel provides a superior combination of thermal and sound insulation as well as light transmission and diffusion characteristics—just half an inch of the material provides 73 percent light transmission with a solar heat gain coefficient of $U = 0.25$.

Light-transmitting Concrete

Old notions about solidity are further shattered in new forms of concrete that transmit light. Although these products are similar to those used for decades in conventional building construction, their paradigm-shifting nature is apparent when colleagues ask me, "But is it still concrete?" Pixel Panels are the result of Bill Price's quest to make concrete a light-transmissive medium. Comprised of a uniform array of acrylic rods set within a concrete binder, Pixel Panels provide translucency at a given viewing distance. Adjusting the ratio of concrete-to-polymer provides limitless variations, achieving as much as 25 percent light-transmittance. Áron Losonczi has developed another light-transmitting concrete, Litricon, that utilizes thousands of fine fiber optic strands to carry light, resulting in a high resolution of detail.

Transparent Aluminum

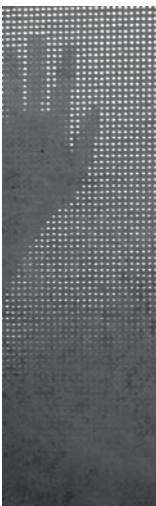
"Star Trek" fans will remember the transparent aluminum material used to contain a large aquarium in the movie



Nanogel pellets transmit light and act as insulators.



Nanogel-filled insulated glazing units at the Milwaukee Zoo.



Star Trek IV: The Voyage Home, but they may not have realized a similar material would be developed in the Fraunhofer Institute. Transparent alumina ceramics permit unprecedented light-transmittance in a strong and durable medium. The next generation transparent corundum ceramics can be manufactured with complex (even hollow) shapes, and exhibit significant bending strength and micro-hardness. The in-line transmission of transparent ceramics is close to 60 percent in visible light and approaches the theoretical limit in the infrared range. An even higher visible light transmission of roughly 80 percent at 1 mm thickness is enabled by a new sub-micrometer spinel.

Faceted colored gemstones of about 1.5 carat have been manufactured with a polycrystalline microstructure of transparent ceramics, and filters have been manufactured for optical applications with the same material. Future applications include super-strong, heat-resistant windows and transparent armor. Like Nanogel, transparent ceramics revolutionize


the window as it is conventionally understood with the added dimension of fire- and blast-resistance, ideal for high-hazard applications.

Optical Camouflage

While these high-performance, light-transmitting materials compel us to question the nature of solidity, a new technology developed by the University of Tokyo seeks to make matter disappear altogether. Scientists at the Tachi Laboratory have developed Optical Camouflage, which utilizes a collection of devices working in concert to render a subject invisible. Although more cumbersome and complicated than Harry Potter's invisibility cloak, this system has essentially the same goal. Clothing—in this case, a hooded jacket—is made with a retro-reflective material comprised of thousands of small beads that reflect light precisely according to the angle of incidence. A digital video camera placed behind the person wearing the cloak captures the scene that the individual would otherwise obstruct and sends the data to a computer for processing. A

program calculates the appropriate distance and viewing angle, and then transmits the scene via projector using a combiner, or a half-silvered mirror with an optical hole. The result is a witness perceives a realistic merger of the projected scene with the background, rendering the cloak-wearer invisible.

Potential applications of this technology include a process called mutual telexistence. Real-time video of remotely located individuals is projected onto surrogate robotic participants via various methods of removing tool-based optical obstructions. Example uses include vehicles that allow pilots and drivers to see more of their exterior environment than is visible through windows and tools that allow doctors to witness an operation through their hands.

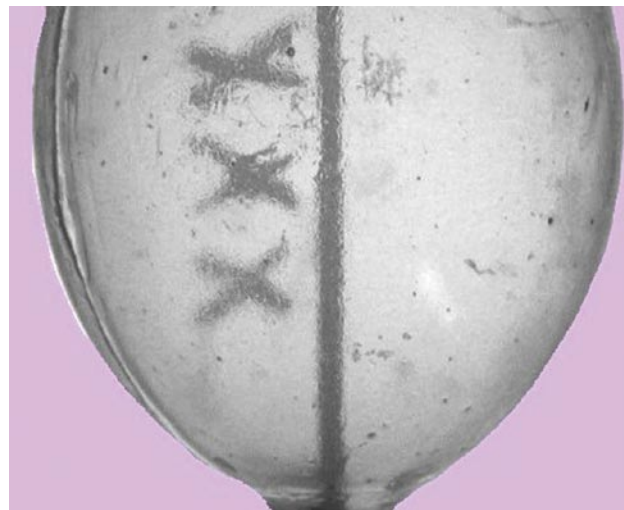
When we consider all of these new disruptive materials and technologies, we see the extraordinary extent to which solidity is being questioned. In the words of Marshall Berman, "All that is solid melts into air." 



Pixel Panels are a translucent concrete.



Colored transparent corundum ceramics.



Transparent ceramics are used in a lamp shield.