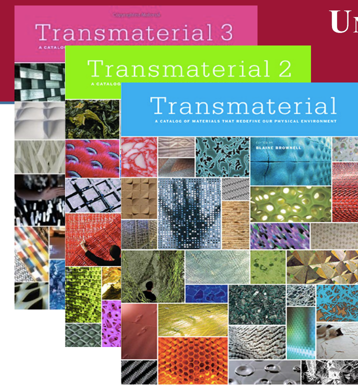
The Feasibility and Sustainability of Architectural Biomaterials

Cataloging emergent biobased & renewable materials that redefine the built environment

Patrick J. Becker[1], Blaine E. Brownell[2]

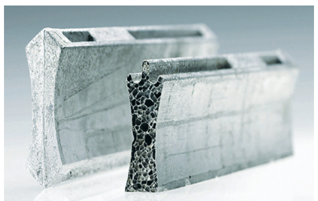
[1]Department of Bioproducts and Biosystems Engineering, College of Food, Agriculture, & Natural Resource Sciences
[2]School of Architecture, College of Design

UNIVERSITY OF MINNESOTA
Driven to Discover™



ABSTRACT

This research was centered on the development of a materials database as a resource for architects, designers, contractors, scientists, and consumers. A primary focus of the research is the feasibility and sustainability of materials with a metabolic or distinctly biological. Application of biomaterials and recycled materials can significantly reduce the impact of construction and the waste it generates. However, this application depends directly on the influence of architects in the design process, specifically material selection. The usage of the *Transmaterial* series, as a resource, can provide designers, architects, contractors, and end-users with access to cutting-edge materials that are changing the built environment.


Alulight- structural aluminum foam, recycled


Wavewall- curvilinear modular wall & ceiling panels

MOTIVATION

- Blaine Brownell is the mentor for this project and his research focuses on disruptive material applications and emergent environmental building strategies.
- Brownell is considered one of the preeminent scholars of advanced materials for architecture and design, having authored the *Transmaterial* series with Princeton Architectural Press (2006-2010).
- The aim of this research was to compile a database of materials for a future edition in the series.
- We've included the newest materials in the built environment, particularly those that are innovative and environmentally friendly.
- Eligible materials are those that are not yet in commercial production and that have unique abilities or characteristics for architectural or built applications.
- Exploring materials research through industry publications and research networks, several hundred materials have been cataloged for future publication.


Chitosan- Chitin-based biodegradable polymer


Javaore- Coffee-based polymer

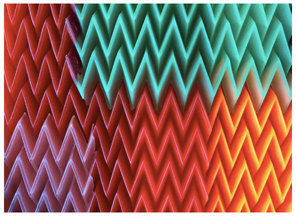
BACKGROUND

- The *Transmaterial* Series explores emergent materials that can transform the structure, spaces, and surfaces of their projects with the latest high tech and environmentally friendly products.
- Emphasis is given to biomaterials, which are notable for their unique environmental or biological factors, including biomimicry, low-embodied energy, biomechanical manufacturing, renewability, waste repurposing, and many other transformative sustainable technologies.

METHODS & MATERIALS

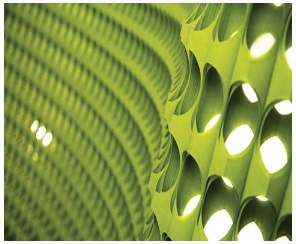
- Material awareness and information acquisition: research was conducted in numerous industry journals, periodicals, professional association newsletters, and university research publications
- Database Entries: Each entry includes a name, images, description, contents, technical information, type, trend, class, readiness for manufacturing, dimensions, specifications, proposed applications, potential impacts, and contact information for the creators.
- Cloud-based software was utilized for real-time offsite team collaboration.
- Communications: One of the primary roles of the undergraduate and graduate research assistants on this was to communicate with the creators of materials in consideration for inclusion.
- Correspondence has been ongoing and was conducted via email to contributors worldwide.
- Compilation: Once obtained, materials were added to the database for review.

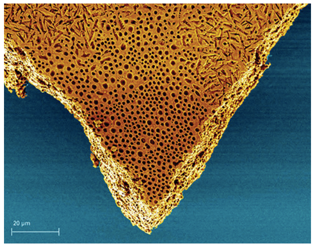

Aerographene- carbon nanotubes, graphene aerogel


Orimetric- Rubberized Origami Textile

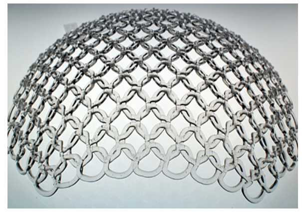
CASE REALITY & FUTURE REALITY

- The built environment is constantly changing and demands new and innovative materials to meet the evolving needs of the planet and its people.
- Numerous materials were discovered as part of this research, many of which have distinct environmental benefits and remarkable characteristics that make them eye-catching and beautiful.
- Most importantly, the future depends on humans ability to create, develop, manufacture, and distribute technologically superior materials that exist synergistically with the natural environment.
- Biomaterials, renewables, and composites represent the future because population growth and expansion of human populations necessitates the usage of materials that further the existence of humanity, rather than threaten it.
- Innovative materials can transform spaces, structures, and surfaces in ways that are not only technologically superior to their predecessors, but that are also environmentally friendly.
- Through the collaboration of undergraduate, graduate, and faculty researchers, the *Transmaterial* series contains the details behind the materials of the future.


Parametre- Non-woven polyester textile



Vapor-responsive artificial skin


Kaynemaile- Polymeric Seamless Mesh (medical)

TECHNOLOGY

- Various technologies were employed in the creation of the materials cataloged in our research.
- Numerous materials were created using nanotechnology, which isolates characteristics of the materials at the molecular and atomic levels.
- For example, a self-flexing membrane which has potential uses as a vapor-responsive artificial skin, is an ionic polymer that passively detects and communicates environmental toxins, protecting the body or organism of which it is apart.
- The development of smart, biomimetic actuators such as this are soft and resilient, and can outperform conventional rigid mechanical devices/materials. Pictured below.
- Other technologies involve creating composites of natural and low environmental impact materials.
- Some examples of this include the combination of lignocellulosic fibers with renewable polymers to create nanocellulose solar cells, color-changing microalgae dye, and Chitosan bioplastic, a chitin-based biodegradable polymer. Chitosan is composed primarily of the exoskeletons of shrimp.
- Materials like Chitosan, and several of the other materials that were part of our research, are known for their characteristics such as improved toughness, durability, flexibility, softness, and biodegradability.


SolarIvy- Nature-inspired networked solar energy devices


Photovoglass- semi-transparent photovoltaic glass

RESULTS

- Architectural biomaterials are indeed feasible within the bounds of the physics that governs their existence. With regard to sustainability, biomaterials contain organic and biological materials, which by their nature have a lower impact than synthetic and engineered products.
- So, if the biomaterials are created with regard to their impact, they are also sustainable. The results of our research includes the database of materials that will form the foundation of future *Transmaterial* publications.
- The images around this poster depict many of the materials that we explored. Exploration such as this is critical and is ongoing, as the development of the materials also continues.
- Future materials will continue to challenge the boundaries of physical possibility while accomplishing the environmental and biological goals of our society as we test the boundaries of the very planet on which we depend for life.

View our work online at transmaterial.net

April 29, 2016