ISSN 2303-4521

PERIODICALS OF ENGINEERING AND NATURAL SCIENCES
Vol. 3 No. 2 (2015)
Available online at: http://pen.ius.edu.ba

Green Materials and Applications

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Abstract

A green material suits most tunefully within ecosystem practices and donates to the achievement of a service-based economy. Due to the properties of non-toxic, organic and recycling, green materials are widely used in various industrial applications. Green materials can be categorized as natural materials, plastics, ceramics and composite materials, and they are extensively utilized in building materials. In this study, green materials are briefly introduced and their applications are shortly reviewed.

Keywords: Green materials, green technology, building, polymer

1. Introduction

Materialsare the stuff of economic life in our industrial world. They include the resource inputs and the product outputs of industrial production. How we handle them is a major determinant of real economic efficiency, and also has a major impact on our health and the health of the natural environment.

A green material is one that simultaneously does the most with the least, fits most harmoniously within ecosystem processes, helps eliminate the use of other materials and energy, and contributes to the attainment of a service-based economy.

Green materials can be classified as natural materials (such as wood), plastics (e.g.plexiglass), ceramics (e.g. kaolin) and composite materials (e.g. wood based composites). Green materials are classified in Figure 1 and Table 1.

Green materials can be used in different places such as environmental area, chemical industry as well as building materials. In this study, green materials are reviewed and then their usage in building and other applications are reported.

2. Elements of Material Solutions in Building

John Young (2000) lately reviewed the materials competence that can be applied to construction materials with a requirement [1]:

a. Materials utilize prevention: It contains a focus on selling services, sooner than products. The great efficiencies resulting from ecological urban design and mixed-use development are in this group.
b. Improved intensity of product employ: Co-housing developments with shared facilities, for instance, can considerably decrease the volume of materials employ.
c. Extended product life: Repair, reuse and remanufacturing are in this group, and in building there is huge potential for deconstruction and the reuse of building materials.
d. Materials recycling: This tends to need more energy, but some form of recycling will be essential for each material at a point in its life cycle.

Although this classification is not adequate in itself to manage all the main dimensions of transforming materials use in building, it provides a structure that can be built upon.

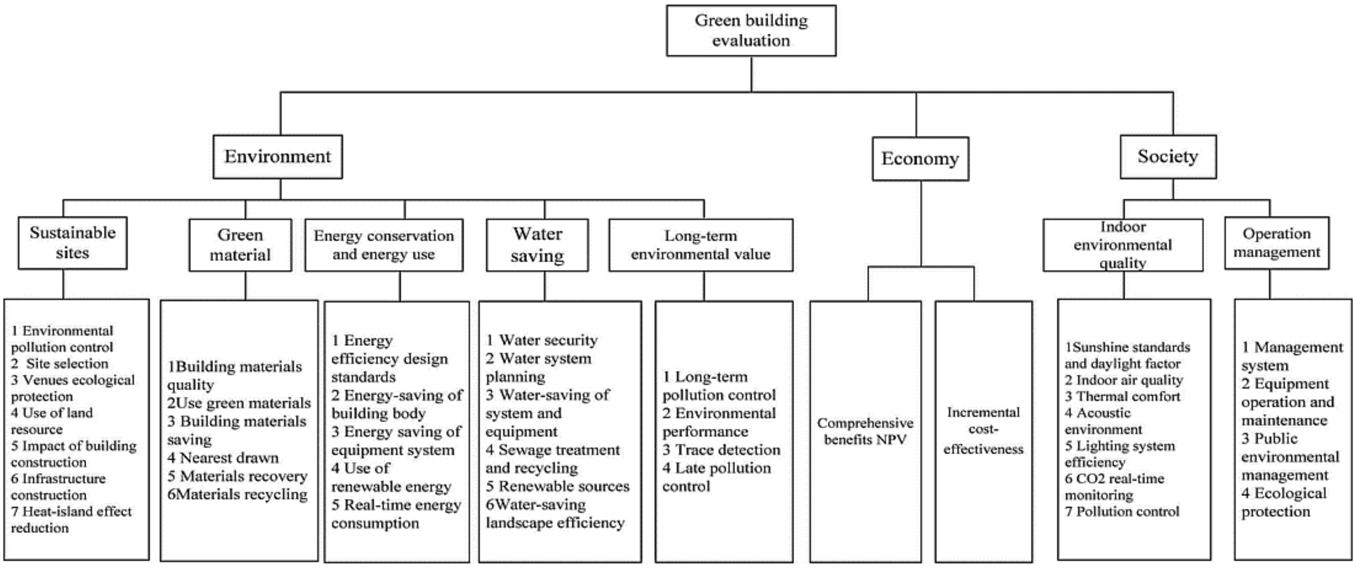
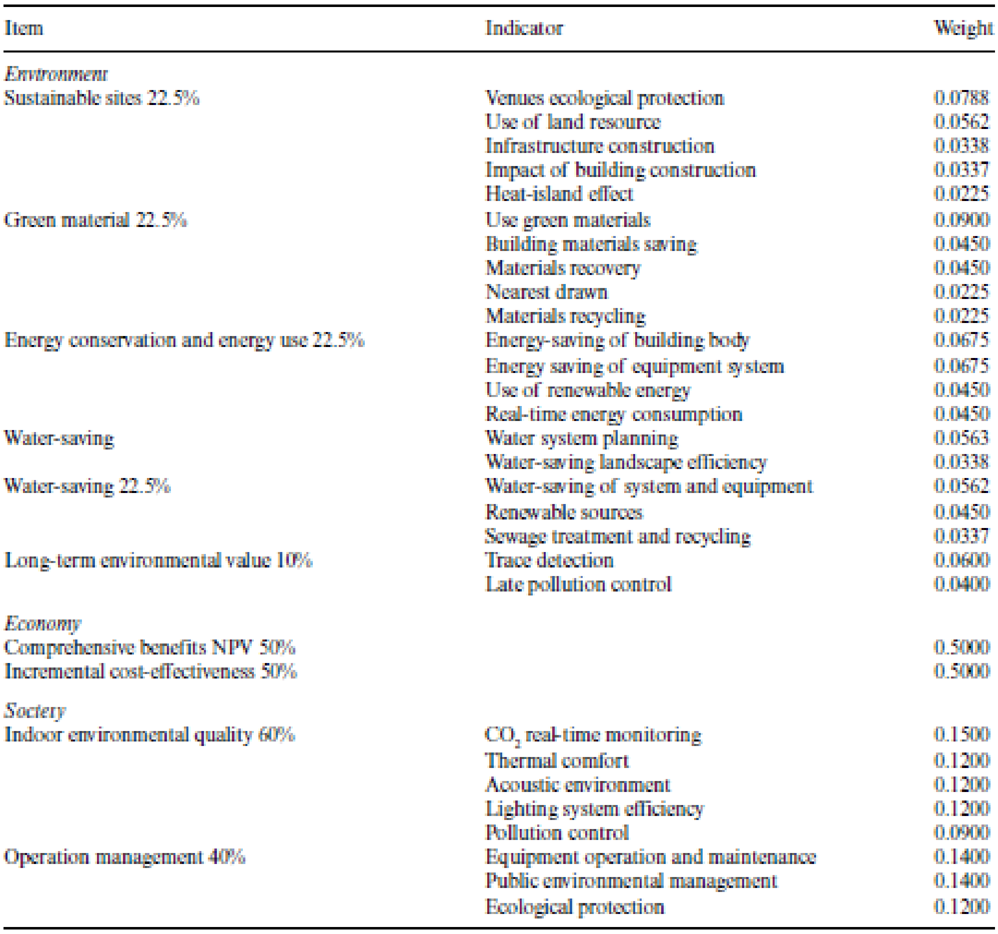


Figure 1. Classification of green materials

Table 1. Triple objective evaluation system of green building.



Item	Indicator	Weight
Environment		
Sustainable sites 22.5%	Venues ecological protection	0.0788
	Use of land resource	0.0562
	Infrastructure construction	0.0338
	Impact of building construction	0.0337
	Heat-island effect	0.0225
Green material 22.5%	Use green materials	0.0900
	Building materials saving	0.0450
	Materials recovery	0.0450
	Nearest drawn	0.0225
	Materials recycling	0.0225
Energy conservation and energy use 22.5%	Energy-saving of building body	0.0675
	Energy saving of equipment system	0.0675
	Use of renewable energy	0.0450
	Real-time energy consumption	0.0450
Water-saving	Water system planning	0.0563
	Water-saving landscape efficiency	0.0338
Water-saving 22.5%	Water-saving of system and equipment	0.0562
	Renewable sources	0.0450
	Sewage treatment and recycling	0.0337
Long-term environmental value 10%	Trace detection	0.0600
	Late pollution control	0.0400
Economy		
Comprehensive benefits NPV 50%		0.5000
Incremental cost-effectiveness 50%		0.5000
Society		
Indoor environmental quality 60%	CO_2 real-time monitoring	0.1500
	Thermal comfort	0.1200
	Acoustic environment	0.1200
	Lighting system efficiency	0.1200
	Pollution control	0.0900
Operation management 40%	Equipment operation and maintenance	0.1400
	Public environmental management	0.1400
	Ecological protection	0.1200

Key areas that are vital to accomplish this materials transformation are:

- Product Evaluation: “What is a green material”?

- Deconstruction and Reuse
- Alternative Materials: the intelligent use of local materials—both natural materials (Rammed earth, straw bale, etc.) provided by the waste stream: tires, cans, etc.
- Eco-industrial production: parks, networks and secondary materials industry.
- Regulation & the State: altering the rules of the game
- Consumption and consumerism

3. Practical Applications

3.1. Kitchen utensils, Green Street™(Fig.2)

Application details:

Application name	Kitchen utensils, Green Street™
Industry	House / Garden
Manufacturer	Robinson Home Products
Material name	Valox IQ
Material abbreviation	PBT

Figure 2. View of several green kitchen utensils [2]

Kitchenware industry leader Robinson Home Products has tapped SABIC Innovative Plastics’ eco-engineered ValoxiQ* resin for its new Green Street™ line of plastic kitchen utensils. A more sustainable, higher-performance material than traditional resins, ValoxiQ resin utilizes up-cycled polyethylene terephthalate (PET) water bottles, diverting them from already bulging landfills. Equally important, this innovative product delivers the exceptional performance and quality that consumers demand in kitchenware, including heat and chemical resistance, U.S. Food and Drug Administration (FDA) approval for food contact, and attractive appearance.

3.2. Housing, medical imaging system (Fig.3)

Application details:

Application name	Housing, medical imaging system
Industry	Medical Engineering
Manufacturer	Grimm Brothers Plastics Corp.
Material name	RTP 300 Series
Material abbreviation	PC

Cross-Functional Team of Engineering, Sheet, and Color Solve Challenges in Medical Housing. The housing was particularly challenging. The sheet product required a V-0 flame rating, coupled with translucency and a critical color match to the desired translucent mint green color. A custom RTP 300 Series polycarbonate flame retardant sheet was created for the housing that met all the application challenges. The Symbia Medical Imaging System went on to receive global recognition for its overall design, including winning a Gold Industrial Design Excellence Award in 2006. Siemens has since changed the Symbia system and the housing material has evolved away from this formulation.

Figure 3. View of a green housing and medical imaging system [2]

3.3. Housing, lawnmower, Husqvarna(Fig.4)

Application details:

Application name	Housing, lawnmower, Husqvarna
Industry	House / Garden
Manufacturer	Husqvarna
Material name	Luran® S
Material abbreviation	ASA

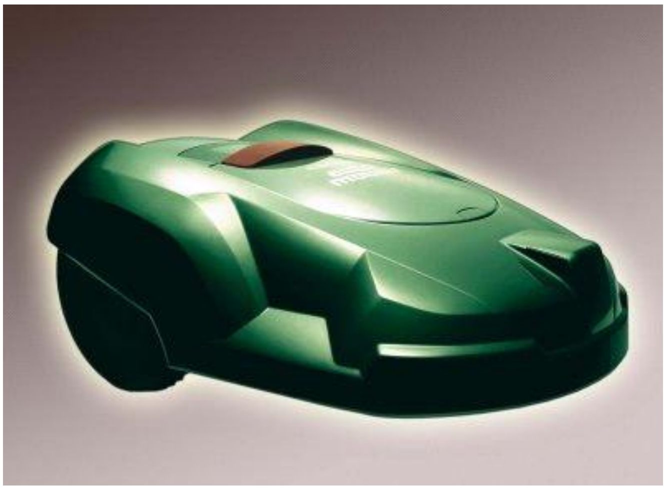


Figure 4. View of a green lawnmower [2]

Automatic lawnmower made by Husqvarna shines with BASF's dark-green Luran®. The first automatic lawnmower made by the Swedish outdoor equipment manufacturer Husqvarna is designed for continuous operation. Once it has been programmed, the battery-powered Automower™ can mow lawns of up to 1800 square meters, needing about one hour for an area of 75 square meters. A housing made of Luran® S, a highly weather resistant material made by BASF on the basis of Acrylonitrile-styrene-acrylate copolymer (ASA), protects the robotic garden helper against heat and rain.

3.4. Handle, disposable applicator, Resofix® Plus(Fig.5)

Application details:

Application name	Handle, disposable application Resofix® Plus
Industry	Medical Engineering
Manufacturer	Resoimplant
Material name	Ultraform® PRO
Material abbreviation	POM

Development of the Resofix® Plus by the company Resoimplant in Regensburg, Germany took only about one year. During an operation for a torn cruciate ligament, the disposable applicator ensures safe and gentle attachment of a new tendon in the knee. The handle (blue) and the various versions of the handle's tip (white, yellow, green) are molded out of Ultraform® PRO from BASF, and colored with masterbatches from BASF Color Solutions produced specifically for this application. The custom-formulated POM (polyoxymethylene) grades for the medical device market offer, in addition to the classical material properties of the engineering plastic, a comprehensive service package for the user that includes Drug Master Files, compliance with medical device standards and tests, biocompatibility tests and most consistent formulations.

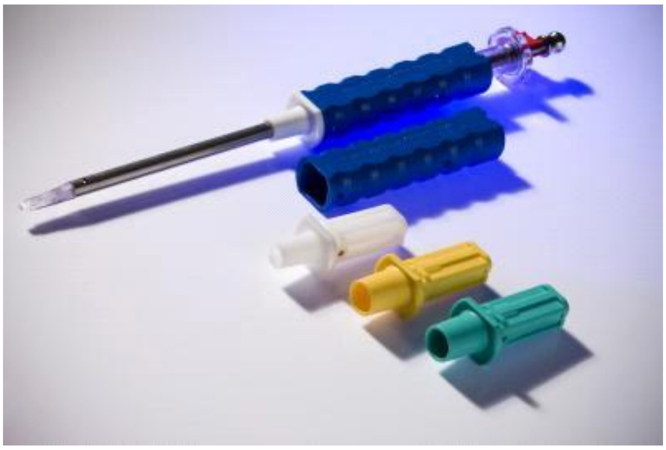


Figure 5. View of a green disposable applicator [2]

4. Suspension spring, Audi

Application details:

Application name	Suspension spring, Audi
Industry	Automotive
Manufacturer	Sogefi
Material name	-
Material abbreviation	EP-GF

The lightweight suspension springs made of glass fiber-reinforced polymer (GFRP), which Audi developed in collaboration with an Italian supplier, even looks different than a steel spring. It is light green, the fiber strand is thicker than the wire of a steel spring and it has a slightly larger overall diameter with a lower number of coils. The core of the springs consists of long glass fibers twisted together and impregnated with epoxy resin. A machine wraps additional fibers around this core — which is only a few millimeters in diameter — at alternating angles of plus and minus 45 degrees to the longitudinal axis. These tension and compression plies mutually support one another to optimally absorb the stresses acting on the component. In the last production step, the blank is cured in an oven at temperatures of over 100 degrees Celsius. The GFRP springs can be precisely tuned to their respective task, and the material does not corrode, even after stone chipping, and is impervious to chemicals such as wheel cleaners. Last but not least, productionrequires far less energy than the production of steel springs.

5. Plastics

5.1. Geon™ E7790 Green | PVC

Composition
Polymer class Thermoplastics
Polymer code PVC
Polymer type PVC

Characteristics
Processing Compression Molding, Other Extrusion
Delivery form Powder
Special Characteristics U.V. stabilized or stable to weather
Applications Electrical and Electronical

5.2. DSM Somos® 7110 UV Postcure | EP

Composition
Polymer class Thermoplastics
Polymer code EP
Polymer type EP

5.3. P84® NT1 15G conditioned | PI-CD

Composition

Polymer class	Thermoplastics
Polymer code	PI-CD
Polymer type	PI
Filler Type	Carbon Fines/Powder

Characteristics

Delivery form	Granules, Powder
Special Characteristics	Heat stabilized or stable to heat
Additives	Lubricants

Product information notes

Polyimid P84® NT - at a glance Excellent performance at high temperatures High strength and excellent shape stability Very good impact resistance High heat deflection temperature Very good creep resistance even at elevated temperatures Machinable with standard tools Low wear and friction behavior Processing by Hot compression molding or Direct forming Application examples bushings, seals, bearings components, guides, gear wheels, and valve parts in the automotive and aerospace industries and in industrial equipment.

Processing notes, Compression Molding

Hot compression molding Production of big semi-finished parts (plates, rods, tubes) High pressure 400 kg/cm² and temperature above Tg (350-380 °C) Cycle time = hours Processing of precise parts by machining Best mechanical properties Direct forming High number of small parts Production of green parts at ambient temperature and very high pressure of 3 t/cm² Cycle time = seconds Subsequent sintering above Tg (350-380 °C) No or little machining necessary.

5.4. PLEXIGLAS® Resist AG 100 | PMMA-I

Composition

Polymer class Thermoplastics
Polymer code PMMA-I
Polymer type PMMA
Additional components Impact modifier

Characteristics

Processing: Film Extrusion, Injection molding, Other Extrusion, Profile Extrusion, Sheet Extrusion, Thermoforming
Delivery: form Pellets
Special Characteristics: High impact or impact modified, Light stabilized or stable to light, Transparent, U.V. stabilized or stable to weather
Additives: Release agent

6. Alternative Materials

The assessment and promotion of green building materials should start with conservative materials (Fig. 9) because these are the most utilized. However, in a transition to sustainability, we must start to consider more and more of materials that fit within ecosystem processes. These are the alternative materials. They differ from place to place, bioregion to bioregion, but some of the better known, and increasingly popular, in North America are straw bale, rammed earth, adobe, cob, cordwood, stone and "earthship" buildings made of old tires and other garbage [3,4].

Figure 6. Green building materials made of old tires and other garbage.

They all make outstanding employ of local resources and are shaped with little energy. Their building processes tend to be labor-intensive and resource-saving. Most are natural drying and eminently recyclable or even reusable. They are also non-toxic and engender little pollution. Some, like earthships (built from old tires) and straw bale construction, make good use of a waste product [5].

Most of the alternative building techniques are modernized versions of traditional building methods that were swept aside by the industrial revolution. Many of the materials are almost ideal materials for the climates where they are found. Materials like straw are natural insulators—one of the totally non-toxic forms of insulation (Fig. 7). Other materials like earth have great thermal mass, keeping warmer in winter and cooler in summer. Whereas many people connect these materials with rural settings, this is mainly since the countryside has been more conducive to experimentation. There is no reason why rammed earth, earthships and even straw bale couldn't be utilized as easily in cities. The future of sustainable cities lay in low-rise, high- and medium-density settlements, featuring lots of plant growth that can offer food, climate-control, energy and water eco-infrastructure, and along with neighborhood employment.

If green cities are to value the natural productivity of the landscape, they must also harness the social productivity of vernacular building and design, and of the informal economy [6]. Economies must find ways of supporting the gardening, preventive health care and self-help building. Alvin Toffler (1972, 1980) first called these emerging informal activities "prosumption"[7]. Toffler was totally ignorant to the ecological dimension, but writers like Schumacher, Illich, Winner, Mumford and Goodman have not only called attention to the importance of these sectors, but also to the need to design and implement technologies to support them [8].

Figure 7. A house built by mud-brick and straw, a natural and non-toxic insulator green material.

The alternative materials are highly suited to "prosumptive" activities. Rammed earth, for instance, takes soil right from the building excavation, eliminating most of the huge processing industry dedicated to wood frame or concrete construction [9]. Most of the techniques can be learned by the people who will live in the buildings. They can contribute in the design. They can see and feel how nature supports them, and understand what they must do to return that support.

The implications of greater use of alternative materials cannot consequently be fully understood with a life cycle analysis. They also occupy social relationships that are essential to creating sustainable communities and economies. They can assist to undermine the forms of hostility of producer from consumer, of professional from client, of design from execution, and of individual from community, that so underlie unsustainable practices.

7. Conclusion

1. The greening and dematerialization of building engage the whole economy. It must take place on every level—production, expenditure and regulation. Green plans have to begin everywhere, but the area of expenditure may be the place where fundamental initiatives have the utmost space for movement. Grassroots action is maybe the most complex since, by description, it is moving from the dominion of the marginalized and fragmented. But it also can request straight to real felt needs and also construct incrementally.
2. The dominion of expenditure is severely rooted in civil society. It not only includes voluntary presumption but is intimately linked to the dominion of small business. This level of business is where most environmental economic options are realized: eco-construction firms, community-supported agriculture networks, auto-sharing networks, green power co-ops.

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