

SUSTAINABLE
DESIGN:
MATERIALS &
METHODOLOGIES
DRIVING
INNOVATION

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INTRODUCTION

The last 5 years has witnessed a revolution in the way in which we see objects. What were once simple decisions about whether something was ‘well-designed’, useful, or beautiful, now have another dimension; is it sustainable? And through this five-year period, the way in which we approach that word, the way we ‘see’ sustainability has changed also. It has ranged wildly from fad to fad, as designers and manufacturers learn about (and fight against) whatever the latest version of “green” is. We have had the bamboo era, with bikes, fabrics, computer casings, plates, and even a phone. There was the PLA era, where we wanted everything to be made from that wonderful corn-based plastic. We have avoided PVC, even when, in some cases it is the better, lower-impact choice. But we have learned a lot. Yes, we have made mistakes, but there has been much experimentation and we have had to do this quickly, much quicker than any other materials revolution so far. We believe we are now at a point where we know how to design sustainably—to avoid the mistakes, lower our impact and make better products. It is of course, obvious now that one type of material selection for all objects was never going to offer the ultimate solution. Each new design needs to approach the problem with the same goal in mind, using different materials to get there. The goal? Lower environmental impact using non-toxic materials that require a minimum amount of energy and water to produce, can be recycled completely or composted, and are part of a closed loop system, preferably controlled by the manufacturer so that they get back their own materials.

Given that we know all this, why then is it so damned hard to achieve?

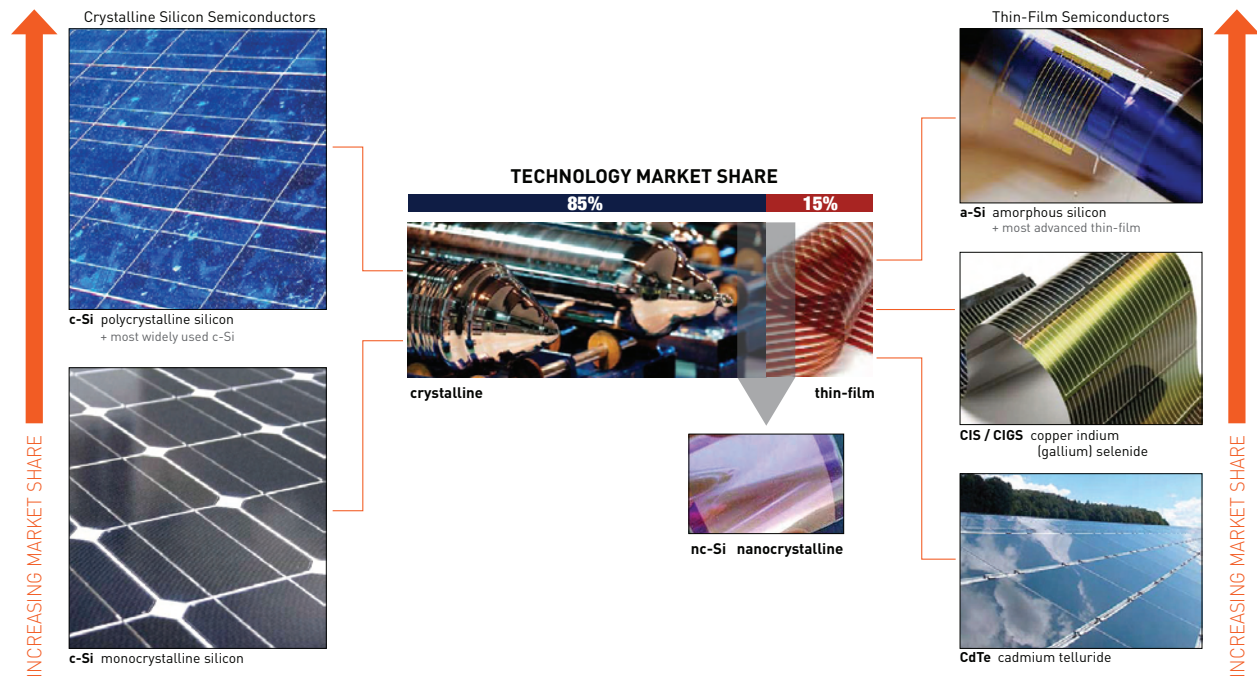
Because almost every bit of progress that has come before it—all those years of brainy chemists, materials scientists, engineers and designers improving stuff—has been sending us in the other direction, away from good sustainable design. **Late 20th and early 21st century consumerism is a high-speed train going in exactly the opposite direction of sustainability.** No wonder it’s hard.

That said, in the time in which we have seen the sustainable design revolution occur, we have also seen the great speed of change of innovation and of our willingness to adopt change. We, as consumers, as producers, as designers all see that change is needed, and are open to it. I believe that truly radical changes in the design and production of objects to create more sustainable versions is possible, and we both now know how to do it, and more excitingly, we have a customer base who wants it and knows why they want it.

The Sections

This report aims to provide information and insight into a range of current topics in sustainability that will bring the reader a greater understanding of the near-future issues in lower environmental impact design. Beginning with a brief look back at where we have come from, including both successes and failures, we are able to track the revolution to understand better where we are going next. On the issue of raw materials, **Resource Issues** takes a rather bleak look at what stuff we are running out of and what can be done about it.

Current Photovoltaic Technologies



without loss of refined silicon. They have the highest commercial efficiency of 22% to 25%. Although monocrystalline silicon is extremely efficient, this technology is a dinosaur compared to polycrystalline and thin film. It is expensive and must be relatively thick to achieve these high efficiencies. As polycrystalline and thin film technology advance, a solar panel using both of these technologies would be as efficient, if not more efficient, than monocrystalline silicon photovoltaics. **Renewable Energy Corporation ASA (REC)** headquartered in Sandvika, Norway, is a leading silicon manufacturer that produces high-efficiency solar grade monocrystalline ingots. REC can be found online at www.recgroup.com/en/.

Polycrystalline Silicon

Polycrystalline silicon photovoltaics (c-Si) are similar to monocrystalline silicon, but are composed of many smaller crystals. This is done by casting large blocks of molten silicon, and carefully cooling and solidifying them. They are, overall, cheaper to make and more widely used, but less efficient than monocrystalline silicon, at about 17% to 20% conversion efficiency. Again, the silicon used in this technology can be up to 40% of the unit cost. Microcrystalline silicon is the combination of polycrystalline and thin film semiconductors, which is designed to utilize the stable high efficiencies of crystalline silicon with the lower materials costs and larger substrate sizes



UV curing systems, have longer lifetimes than standard UV lamps, and their super-short cure times speeds processing. LEDs can be turned on and off instantly, without the need to warm up or cool down required with conventional bulbs. UV curable inks can be printed onto a variety of polymers, paper. These curing systems are particularly well-suited for heat sensitive materials because LEDs remain cool during use. **Toyo, Imtech, Sun Chemical,** and **Hexion** are among the companies that have recently introduced LED-curable inks. The technology is still working out problems with bulb lifetimes and decreased intensity over time, so we don't expect LED systems to immediately replace conventional UV-curing systems.

Pigment



Necessity is credited with being the mother of invention, but some of the best inventions are the results of accidents. A new pigment created by researchers at **Oregon State University** joins other accidental discoveries like Gore-tex, silly putty, Post-it notes, and microwave ovens. Blue has historically been one of the most difficult pigment colors to develop, and especially to develop safely and inexpensively. Cobalt blue can be carcinogenic, prussian blue can release cyanide, and other blue pigments are unstable in heat or acidic conditions. This new blue pigment was discovered in the course of creating unique electronic materials containing manganese oxide combined with the elements yttrium and indium. When the compound was heated to nearly 2,000°F (1,093°C), the result was a brilliant blue crystal. The discovery has generated considerable interest in industry, and is likely to become the basis for commercial pigments in the near future due not only to its bright color, but its durability, low-cost, and the non-toxic constituents. (<http://oregonstate.edu/ua/ncs/archives/2009/nov/accidental-discovery-produces-durable-new-blue-pigment-multiple-applications-0>)