The Future of Building Materials

Discover the trends in concrete, steel, wood and glass.

PLUG AND PLAY
SMART CITIES

Index

Introduction

Building materials are quite literally the fundamental building blocks of our society. All major construction projects start with the same key ingredients, typically used and manipulated in the same ways.

There are countless opportunities to make bold and exciting changes in the way we build things, from the bricks and butter to the tools that analyze the construction process. **Every material represents a chance for technological advancement.**

Although the focus here is construction, the vision for this conversation is much larger. Ultimately, when we speak about innovation in construction we are speaking about innovation in cities. For cities to be truly smart and sustainable, the buildings and structures within them have to be smart and sustainable. That begins with the core materials being used.

The following pages will expand upon current innovation and investing in four of the main materials used in construction today: Concrete, Steel, Wood, and Glass.

Concrete

It would be impossible to discuss building materials without bringing concrete into the mix. It is still the most used material in the world, pound for pound being used twice as much as steel, wood, plastics and aluminum combined. It is still so much in use, despite other material advances, because of its strength, durability and longevity. Concrete doesn't burn, rust or rot, and is more cost effective than any of the alternatives. Taking a closer look at concrete, there is still plenty of room for improvement and innovation.

The innovation opportunities in concrete start with the mix itself. Essentially, concrete is a mixture of cement and aggregates. When it comes to the aggregates, the main innovation opportunities are in their makeup. For instance, one way of recycling old concrete is by using reclaimed crushed pieces as coarse aggregates. The innovation opportunities in the cement can come in the form of novel materials, but the biggest steps forward in recent years surround the production of cement. Cement production is notorious for producing tons of CO2 and being energy intensive. While that is a huge problem, it creates lots of space for startups to innovate. Green concrete brings with it opportunities for certification as well as extreme reduction of the carbon footprint of a project. The last place where innovation can be found with concrete is during the curing process. Curing can be a delicate thing, requiring the proper conditions so as not to cause potentially project-ending faults down the line. By incorporating sensors into the curing process, the optimal conditions can be maintained more often, and if nothing else, errors can be predicted before they actually manifest. The opportunities for technological advancement in concrete are numerous, and they are definitely not limited to the mixture itself. There is still plenty to do when it comes to the materials that surround and support concrete.

Traditionally, reinforced concrete is supported by steel rebar and carbon fiber structures. Rebar is not without room for improvement, with some startups trading corrosion-prone steel for other metals, or even reimagining rebar wrapping and geometry. Carbon fiber composite innovations have skyrocketed over the past five years, with novel and more cost effective production methods coming onto the market.

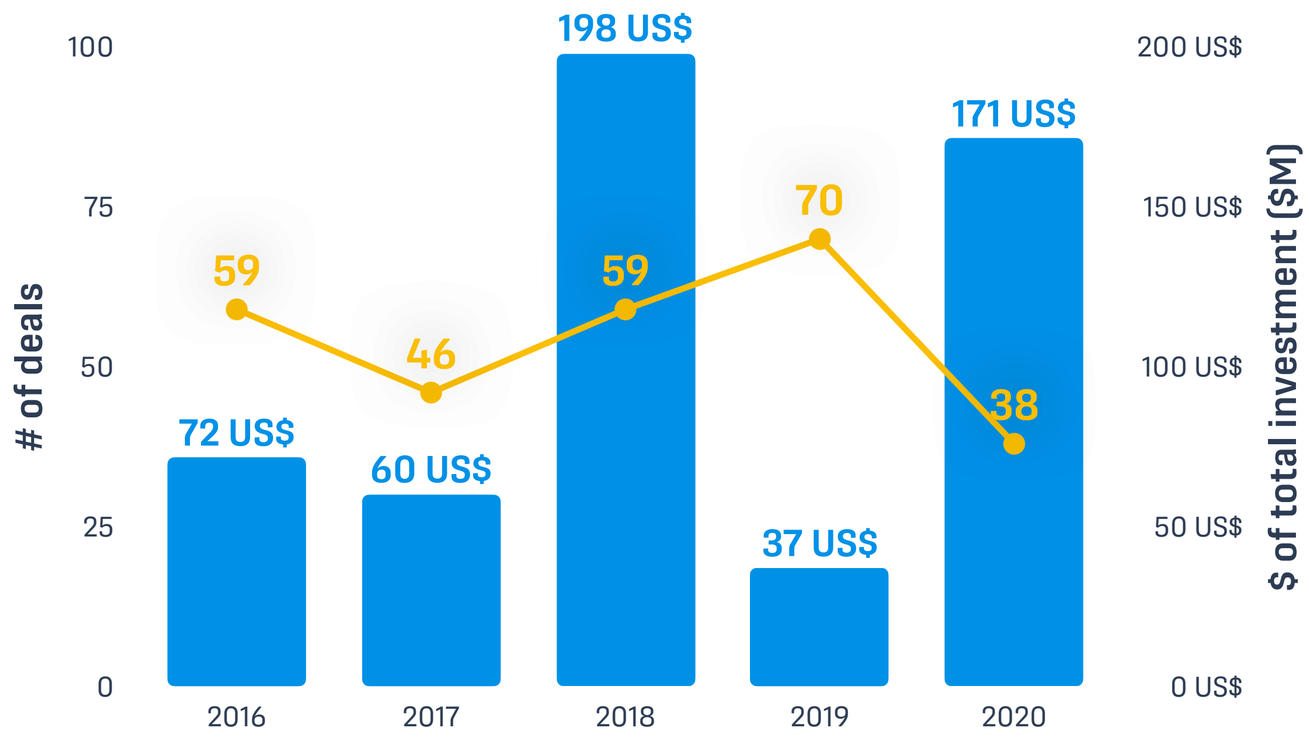
This document will attempt to explore some of these areas through the lens of startups.

Venture Capital Investing

The following data illustrates the investments that have been made over the past five years in the concrete space. It ranges across all investors that are considered to be in the venture capital ecosystem, including corporate venture capital arms, and goes through October of 2020.

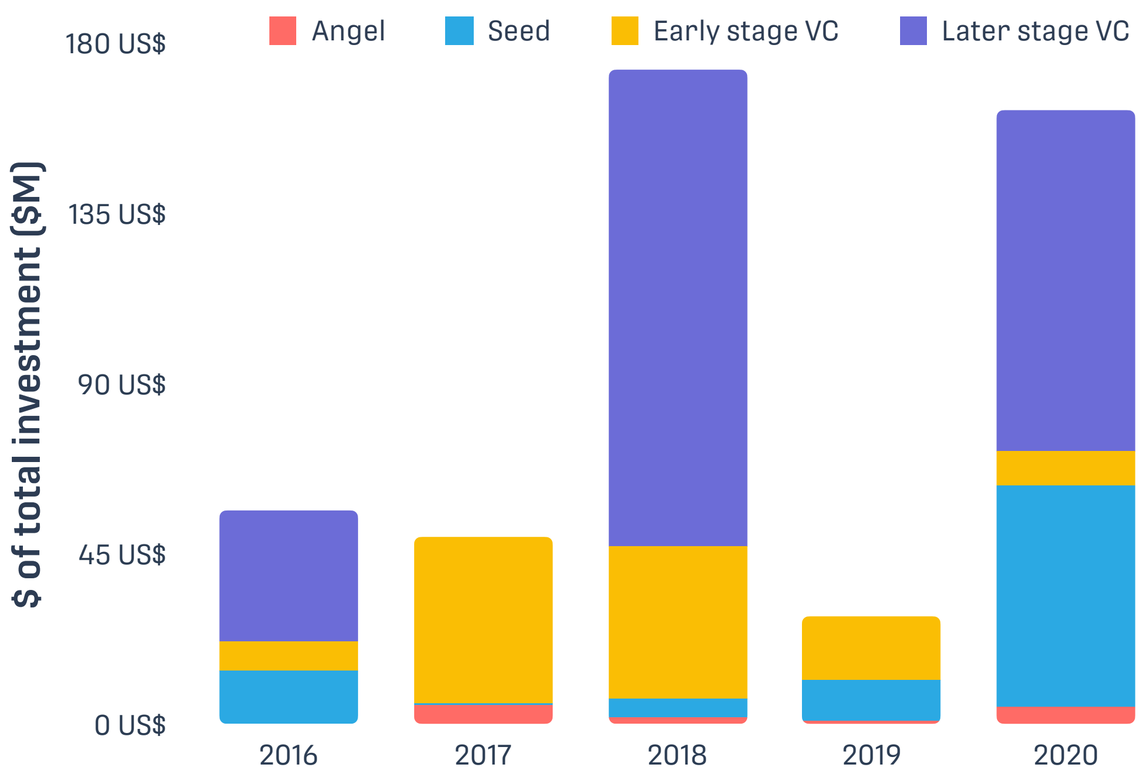
Total Capital Invested and Deal Count

As you can see from the graph below, the volume of investments in concrete tends to be fairly low year to year. However, there were two major spikes in activity in 2018 and 2020.



Investing by Stage

The unusual activity in 2018 and 2020 was probably due to just a few, large, late stage investments skewing the numbers (Prescient raising $95M in 2018 and $90M in 2020).



* All data comes from Pitchbook.

Startups addressing this topic

New advances in concrete technology can take many forms. The following startups address topics ranging from new materials for the concrete itself, to sensors and analytics around the state of poured, to innovations on the pouring methods themselves.

alcemy is building a predictive quality control AI which will enable production of low-carbon green concrete at scale

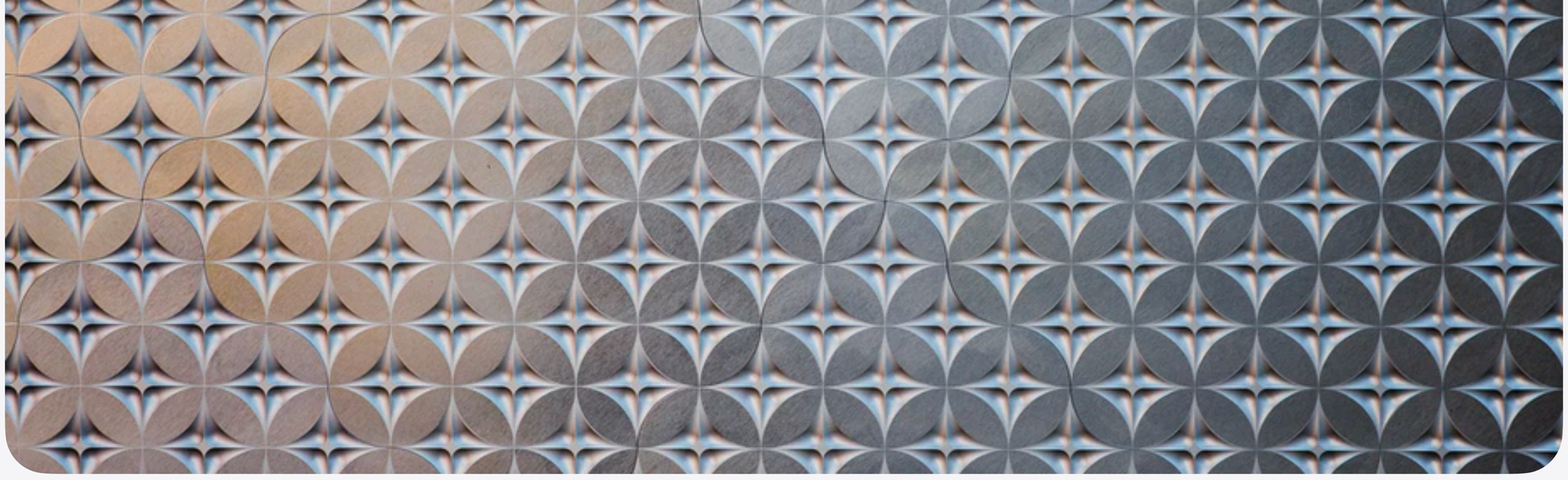
A wireless IoT sensor that provides real-time temperature and strength information from on-site concrete castings

Turning carbon dioxide emissions into construction materials and products without a need for carbon capture

Automated concrete manufacturing of block pavement via robotic 3D printing

Nanogence develops a smart additive that significantly enhances the quality and mechanical strength of cement

This selection of startups attempts to cover a wide range of topics, but there are many more in this arena. For more information about startups working on concrete solutions, feel free to reach out to the Plug and Play team.



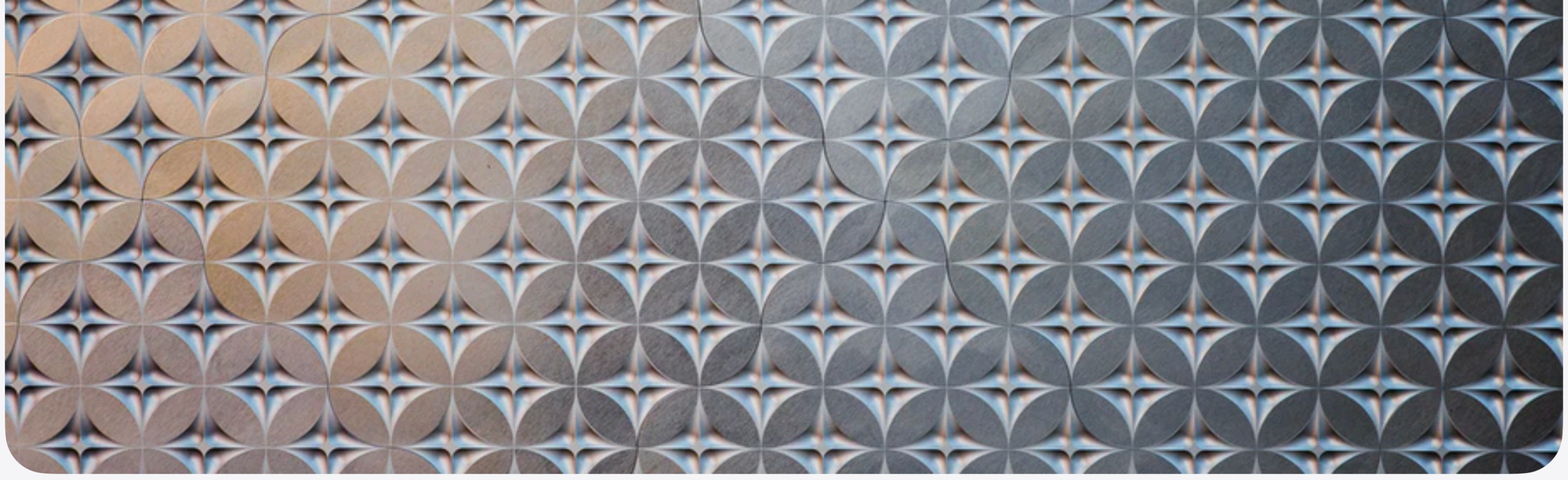
Steel

Since the industrial revolution steel has gained fame and has been one of the primary building materials in high rise buildings and other infrastructures all around the world. Steel is used for structural sections and non structural such as HVAC material to infrastructure building for tunnels, bridges, railways, etc. Its recyclability, durability and earthquake resistance makes it a top choice for builders.

Steel became very popular in the late 1800s and has been one of the most commonly used materials in construction. The steelmaking process is relatively simple, however incredibly crucial in order to achieve the highest strength of the final product. Iron is heated and treated to get the most pure blend and once cooled will set with high durability. When heating, steel is shaped depending on use, like rebars, beams or channels. When constructing buildings, about 25% is used for structure and 44% is used as rebar to set with concrete where most of the strength of the building lies. Rebar actually accounts for the majority of the steel used in buildings and industrial (tunnels, bridges, utilities).

Innovation in steel is needed for insulation. Steel produces poor insulation and, as a result, requires additional material to insulate buildings. Additionally, rebar is one of the most steel-based materials in construction, so automation in this space would be ideal to speed up the building process.

The next few pages will walk through how venture capital and startups are shaping this space.

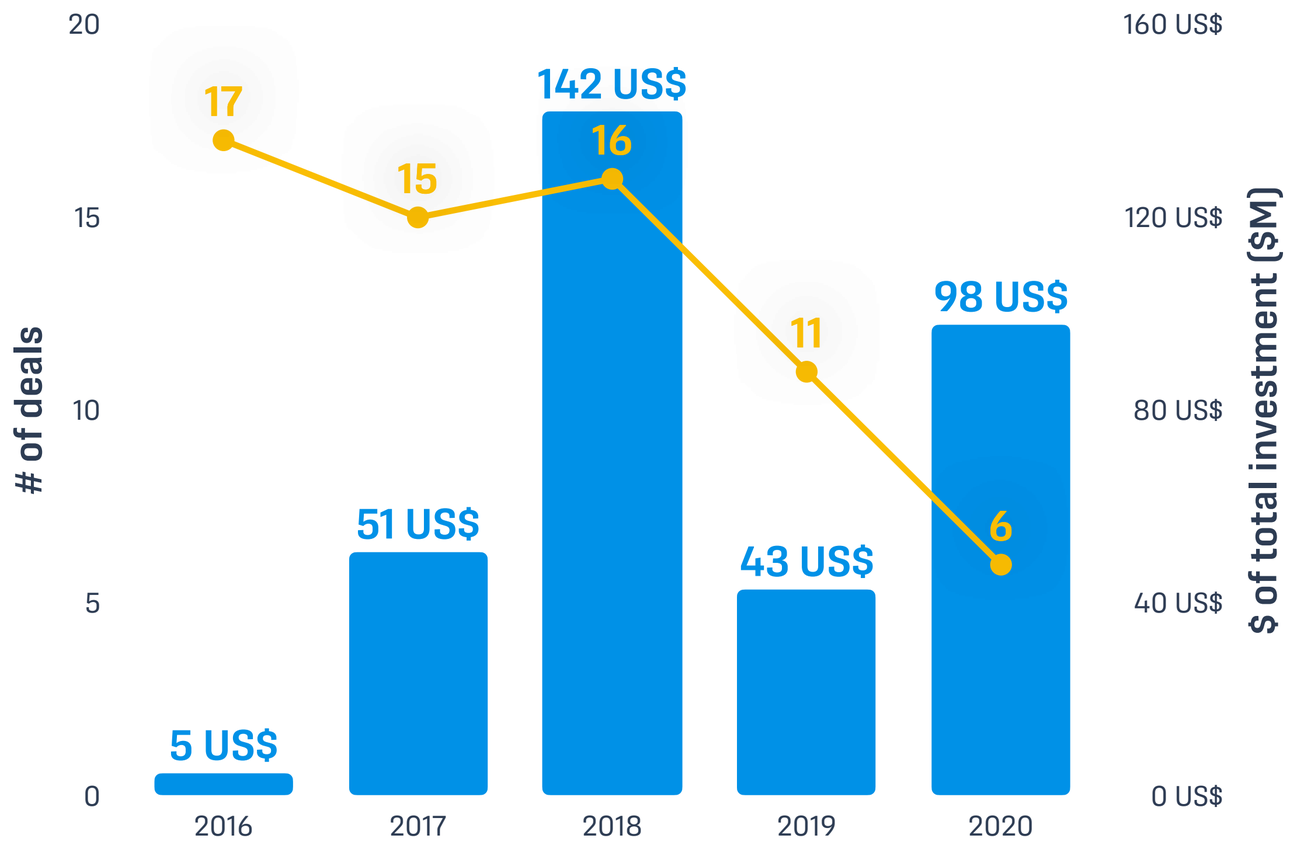


Venture Capital Investing

The following data illustrates the investments that have been made over the past five years in the steel space. It ranges across all investors that are considered to be in the venture capital ecosystem, including corporate venture capital arms, and goes through October of 2020.

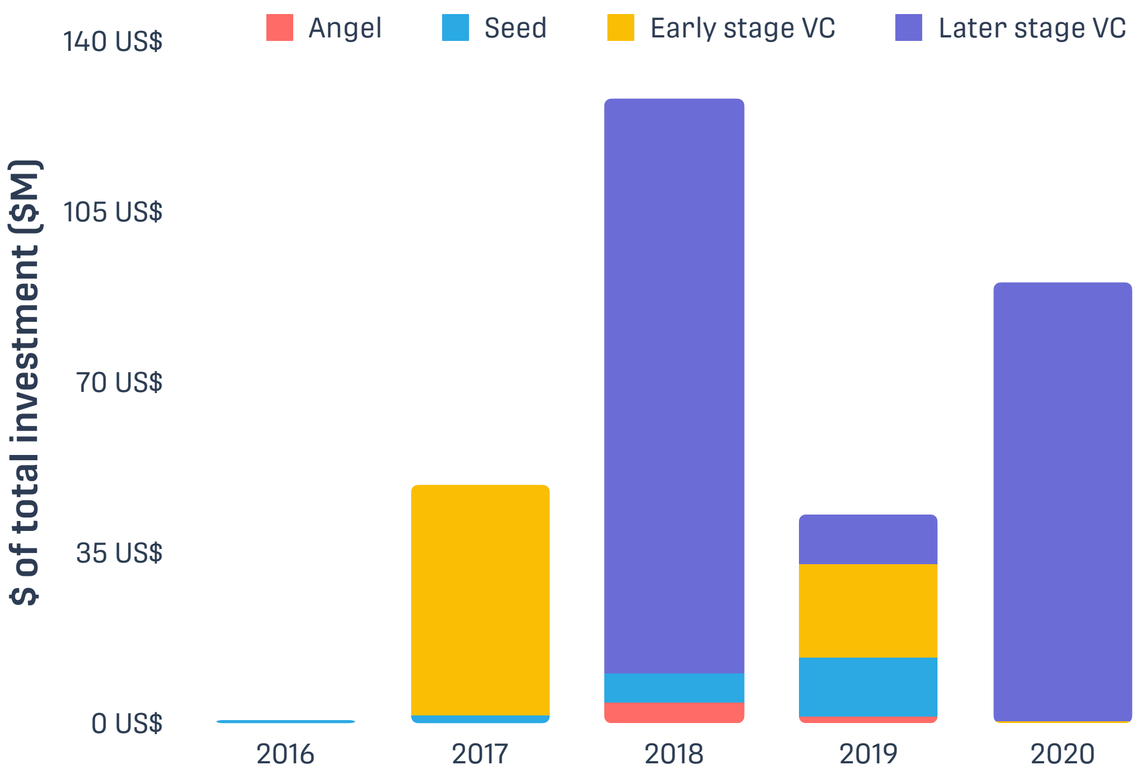
Total Capital Invested and Deal Count

The most striking feature is that the deal count has been steadily decreasing over the past five years. However, the overall volume of investment has not followed a similar pattern, as we can see a high volume combined with the lowest deal count this year.



Investing by Stage

The investments in steel have been more and more dominated by later stage activity. Although there are just a few investments being made each year, the overall volume is fairly high.



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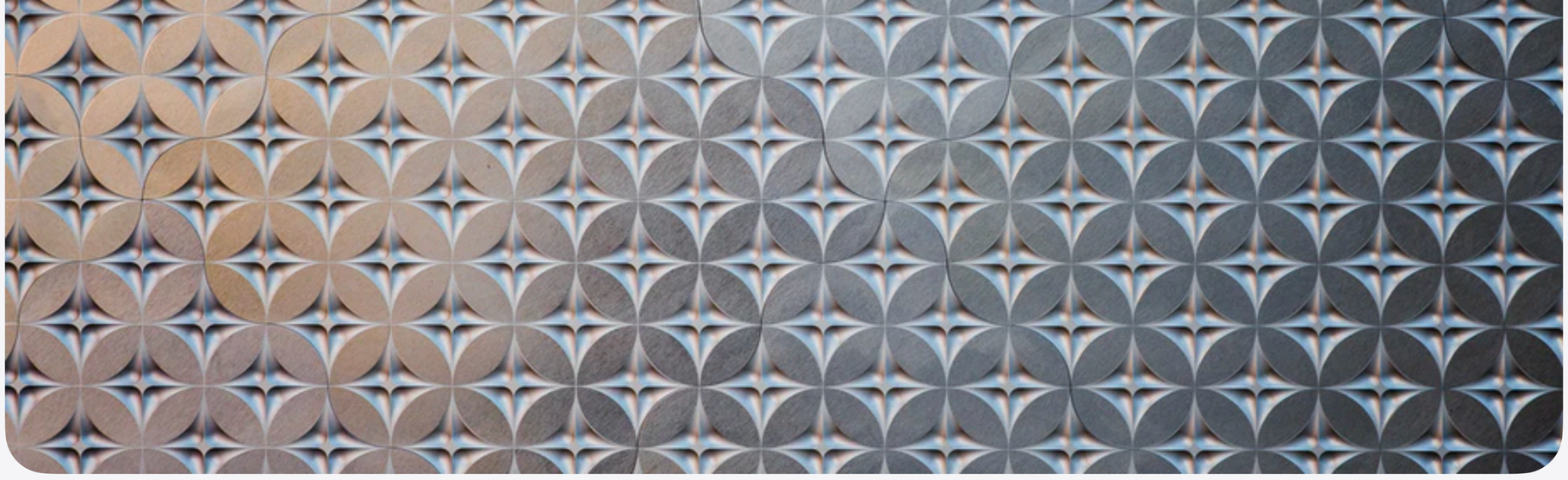


Startups addressing this topic

Although steel has advanced significantly over the years, from improvement in tools to steel structured buildings, we continue to see innovation. There are big enterprises and renowned universities researching and developing new and improved steel material. The following startups are disrupting the space with not just new materials, but new methods of using the material as well.

REBARTEK

Rebartek automates the installation of concrete steel reinforcement bars using robots and AI

MODUMETAL

Form nanolaminated alloys onto base materials at an industrial scale in an environmentally sustainable manner

VERO SOLUTIONS
VERTICAL INNOVATION & URBANIZATION

A disruptive, patent-able hybrid (steel and concrete) modular construction technology

FORTECO® FRAMING COMPANY

Floor and Wall Framing System utilizing innovative and strong composite concrete and steel framing with integral insulation

HYCONNECT
SMART ENGINEERING

Solution for adhesive-free joining of metals and composite materials

Wood

Wood is one of the oldest materials used in construction and one of the most common materials used in home building within the US to this day. Wood makes up a majority of the material used in a home, such as roofing, walls, doors, and flooring. For commercial high rise buildings, wood is primarily used for doors, flooring, and cabinetry.

Wood is a perfect material for building, due to its availability and affordability. Trees are cut down, treated and sanded before being used as a building material. Most importantly, wood must be seasoned before being used, which is the act of removing all moisture from within the tree. Once the wood is ready to use, it is cut in various forms to be used in different areas in the construction build. Although wood building has come a long way and has improved over the past 50 years, there is always opportunity for innovation. Wood lacks innovation in a few crucial areas, one of which is fire resistance. It needs to be fire resistant to be of best use and to outperform brick and concrete.

There has been some innovation in this space, but more is needed to make it readily available.

Where wood is innovating and making headway as a building material is through its flexibility. Two popular ways of using wood are Dowel Laminated Timber (DLT) and Cross Laminated Timber (CLT). DLT and CLT are allowing wood to be stronger and allow taller structures to be built. Most recently in Norway "The Mostarnet", a 280 foot tall (18 stories) building, was constructed entirely out of wood. Designed by Voll Arkitekter and owned by AB Invest.

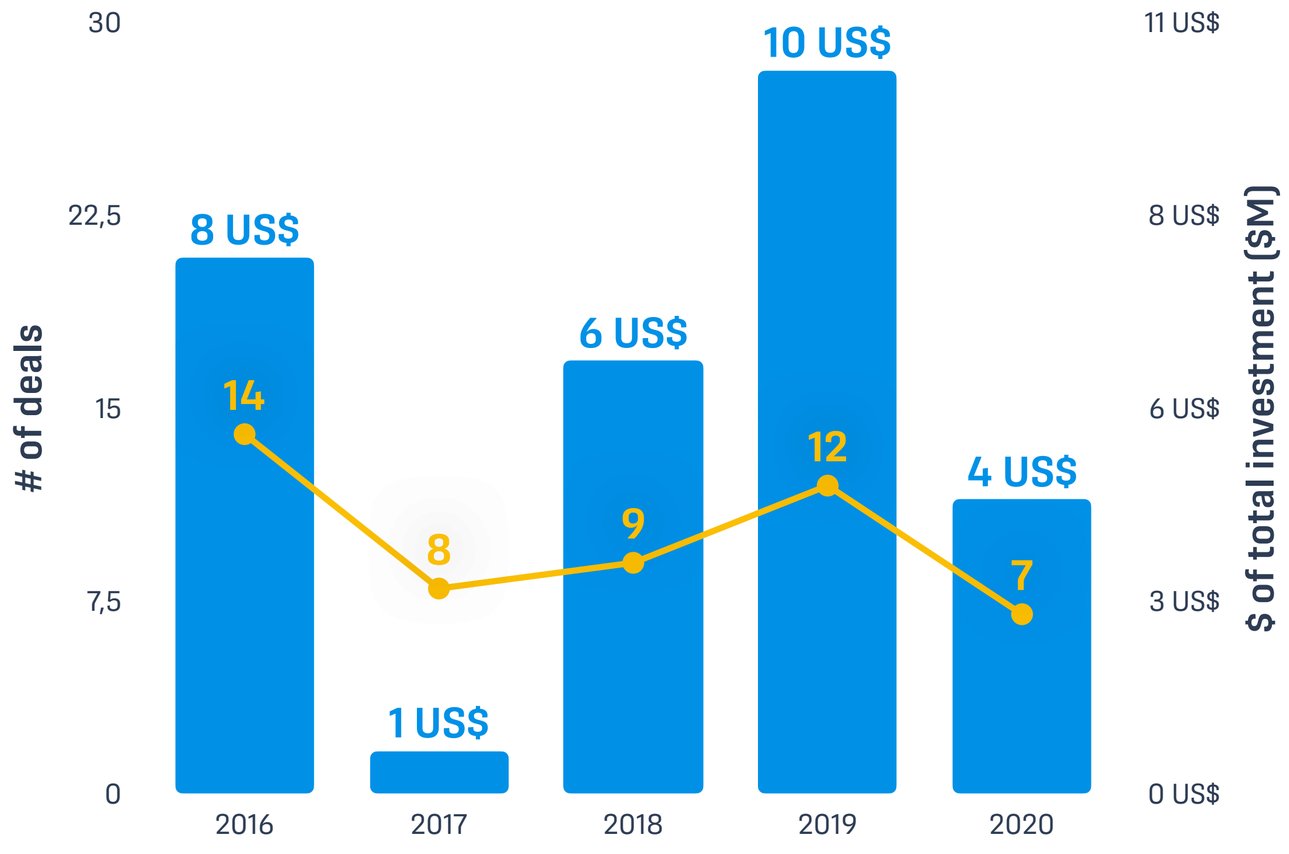
The most interesting way wood is being used is in prefabricated buildings. Companies like Katerra are changing the way wood is used by constructing buildings in a warehouse and assembling onsite. This is due to the flexibility and strength of wood.

Venture Capital Investing

The following data illustrates the investments that have been made over the past five years in the wood space. It ranges across all investors that are considered to be in the venture capital ecosystem, including corporate venture capital arms, and goes through October of 2020.

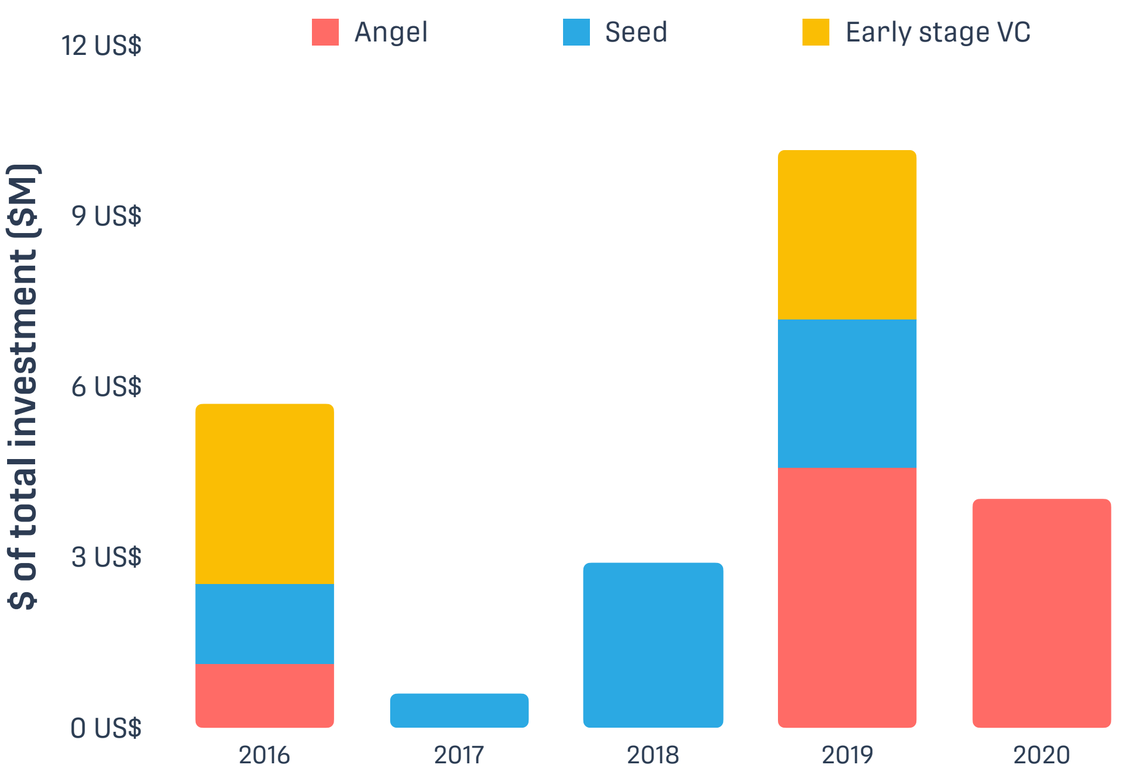
Total Capital Invested and Deal Count

Venture capital investing in this space has been sporadic and the overall investment volume is low. This is probably due to the fact that startups focusing on wood are unlikely to achieve venture bankable returns.



Investing by Stage

Over the past five years, investing in wood has been almost entirely early stage, with lots of angel activity. This could indicate it as a new market, with later stage investments coming down the pipeline over the next few years.



* All data comes from Pitchbook.

Startups addressing this topic

Wood as a material has several use cases, from buildings to furniture to beautiful aesthetic decorations in homes or offices. It's very important that we recognize that wood comes from trees that grow at a slower rate than they're being used at. For this reason, we have new companies looking to make a change in our environment while at the same time improving the quality of this material.

An innovative, partially-prefabricated solution allowing homebuilders, general contractors and framers to build standard and gable walls 10x faster

100% waterproof solid wood composite made from real wood chips - with a minimal carbon footprint

Engineering the next generation of high-performance wood materials

High performance biocomposites for a sustainable future

Plant-based fibers and resins that outperform traditional materials while preserving elegant natural grain finishes

Glass

Architectural glass has been used more and more in modern construction, not only as windows, but also as external walls. Glass is perfect for any case in which light transmittance, reflectance, absorbance or some combination of the three is important to the design.

In fact, the transmittance, reflectance, and absorbance of light is exactly where much of the innovation in glass lies. Manipulating different wavelengths of light can achieve effects ranging from insulation to aesthetics. There are also opportunities to impregnate glass with particles and electronic devices so as to change its properties with the flick of a switch or simply by shining a light upon it.

One example of this type of glass is known as electrochromic glass. With electrochromic glass, you only need to apply an electrical current and the glass will change color or even fog over completely to become opaque. While electrochromic glass is not a new technology, the innovation these days comes with cost effectiveness, as the process has traditionally been quite expensive. Oftentimes, an electrochromic effect is achieved using a thin film. Thin films can also be used to add a variety of other properties to glass.

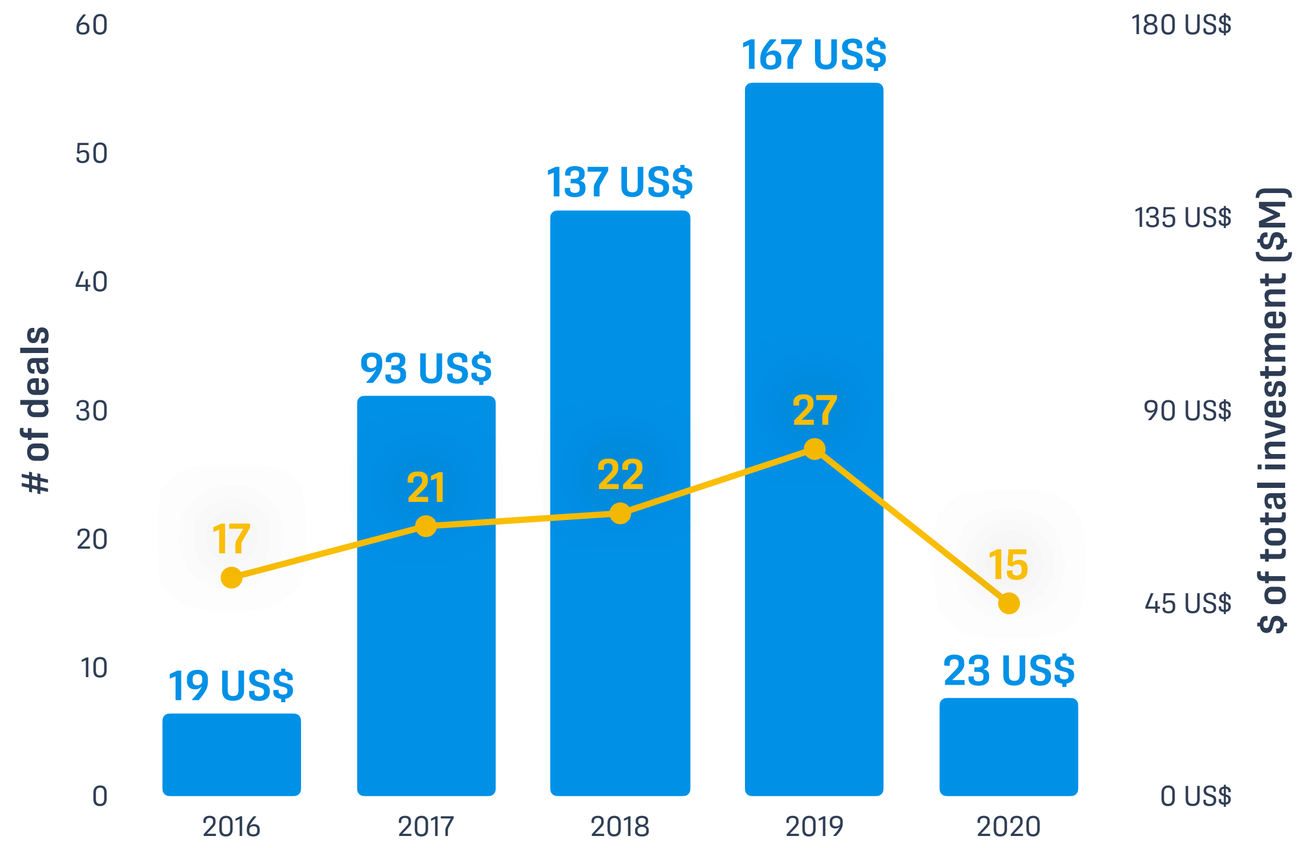
Adding a thin layer to glass is one of the easiest and most cost effective ways to change its properties. Thin films can do everything, from cooling to manipulating the type of light that is allowed to pass through. While electrochromic glass tends to deal with visible white light, one can imagine applications that deal with other types of light. For instance, by manipulating certain direct light sources, holograms and pictures can be displayed directly on glass. By blocking the infrared spectrum, some of that energy can be converted into a useful form. The opportunities are endless.

Venture Capital Investing

The following data illustrates the investments that have been made over the past five years in the glass space. It ranges across all investors that are considered to be in the venture capital ecosystem, including corporate venture capital arms, and goes through October of 2020.

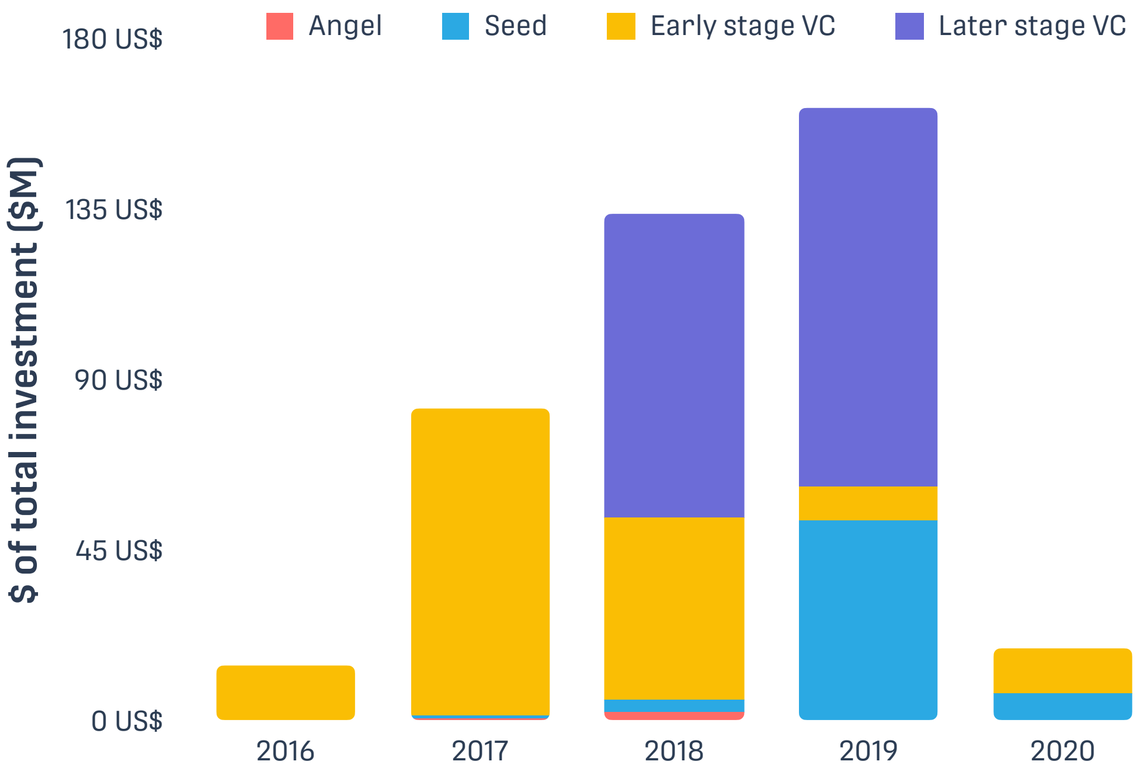
Total Capital Invested and Deal Count

Investing in the glass space has been increasing steadily over the past five years, but it took a major hit in 2020 with the pandemic.



Investing by Stage

Investing in this space has been moving towards the later stage over the past couple of years. This could indicate a maturation of the market, but with this low deal count it is more likely an indicator of a few later stage deals in 2018 and 2019.



* All data comes from Pitchbook.

Startups addressing this topic

Innovation in glass mainly consists of technologies to add properties to glass facades. The following startups represent thin films and solutions to provide light manipulation, electricity generation, and climate control among other properties.

Furcifer

Next-generation electrochromic films with a broad range of applications that include architecture

PHYSEE

SmartSkin can autonomously power, sense and regulate your building's climate

LIGHTGLASS

LIGHTGLASS is the first industrially available, self-luminous glass for the world market

ubiquitous energy

A highly transparent, color-neutral coating that generates electricity from sunlight

DeNoize

Active noise cancellation on glass facades

Other Material Advances

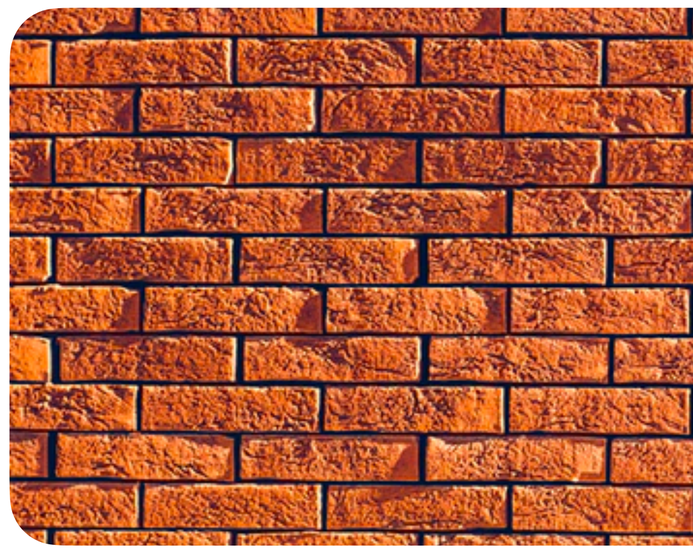
With the world advancing and the population expanding, buildings are becoming more than just structures. They're becoming more abundant and damaging to our planet earth. Densely populated cities continue to build in order to house their citizens and each new home is another vehicle added to the road. These two trends combined continue to produce more carbon monoxide than the environment can control. Understanding these challenges offers us an opportunity to research and further develop the materials we use every day to grow the built world.

Buildings and infrastructures are built using various materials in addition to concrete, wood, steel, and glass. Current research and development of materials is not only to improve quality of materials, **but to introduce an environmentally friendly process of creating these new materials**. Some examples include light-generating concrete, cigarette butts recycled into bricks, or pollution-absorbing bricks. In the meantime, many more new materials are being developed by research institutes, universities, and companies around the world.

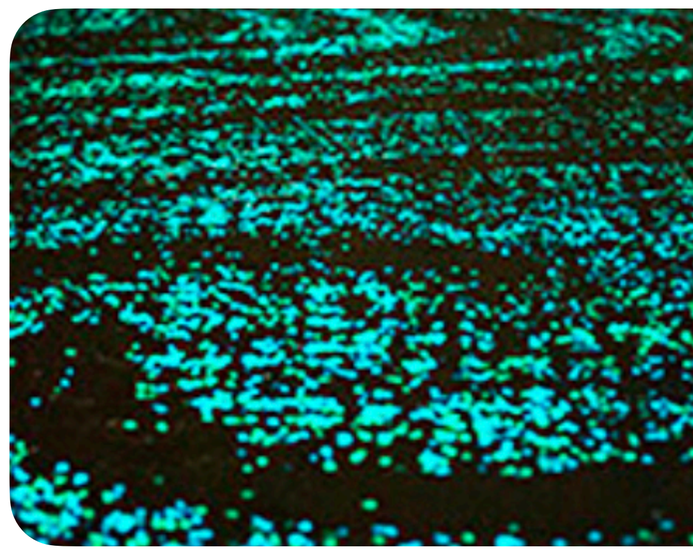
Pollution is a growing problem and so is material waste. Energy waste and deforestation all contribute to the ongoing environmental issues we see today. New material advances provide two benefits to the environment, one of which is recycling and repurposing which improves the utilization of our natural resources. The other benefit is these new materials can act as more than just a building material and can improve air quality and even offer lighting.

On the next page you will see some very interesting building materials that aren't seen in everyday buildings. These materials must still prove their ability to be mass produced and meet existing building code requirements.

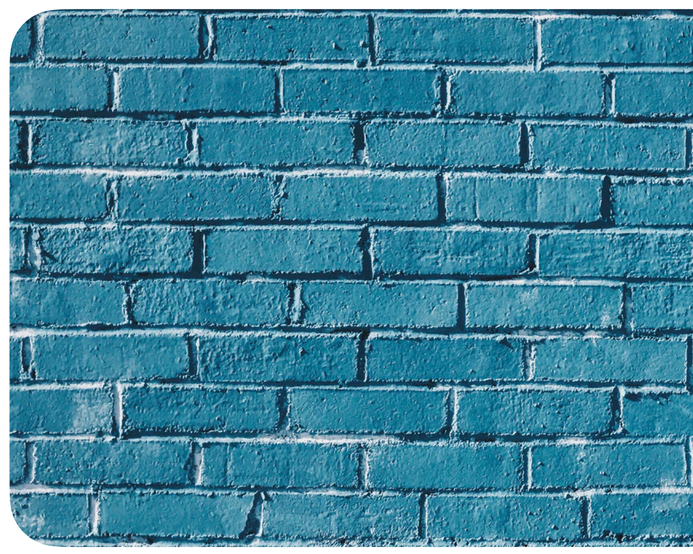
Millions of cigarettes are manufactured and smoked through out the world. Not only harming those who smoke, but the environment as well. As cigarette butts are tossed and scattered throughout the streets polluting the soil. By creating bricks from recycled cigarette butts, it reduces the waste from cigarettes as well as offers an alternative building material for the construction industry.



Cement is a very common material, utilized to make buildings, roads, bridges, and tunnels. Imagine having concrete that emits light at night, simply by absorbing daylight. The use cases are immense and extremely environmentally impactful. This material most likely be a slow material to adopt as a



As the world continues to sink into climate change and pollution, scientists are pushing the limits for a better future. As a result pollution absorbing bricks are being created to tackle the problem. Brick acts as a building material for homes or commercial buildings while at the same time insulating and decreasing pollutants in the air. This new material will be the future of buildings.



Source: [LetsBuild]

To stay up to date on the latest Smart Cities technology startups, join the Plug and Play Platform. Our Smart Cities accelerator program runs twice a year boosting our startups through corporate business development, networking and pitch events, world-class mentorship, and the potential for investment.

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