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Application of Building and Construction Materials using Carbonized Biochar to accomplish Net Zero in Climate Change Area.

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ABSTRACT

While taking a backseat to the health crisis over the last few months, climate change increasingly shapes our daily experience. Wildfires, droughts, hurricanes and pollution are now everyday occurrences. Yet, in the face of this worsening crisis, we are witnessing the rise of a new generation of innovatorsAn IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.Climate models project robust differences in regional climate characteristics between present-day and global warming of 1.5°C, and between 1.5°C and 2°C. These differences include increases in: mean temperature in most land and ocean regions (high confidence), hot extremes in most inhabited regions (high confidence), heavy precipitation in several regions (medium confidence), and the probability of drought and precipitation deficits in some regions (medium confidence).All pathways that limit global warming to 1.5°C with limited or no overshoot project the use of carbon dioxide removal (CDR) on the order of 100–1000 GtCO2 over the 21st century. CDR would be used to compensate for residual emissions and, in most cases, achieve net negative emissions to return global warming to 1.5°C following a peak (high confidence). CDR deployment of several hundreds of GtCO2 is subject to multiple feasibility and sustainability constraints (high confidence). Significant near-term emissions reductions and measures to lower energy and land demand can limit CDR deployment to a few hundred GtCO2 without reliance on bioenergy with carbon capture and storage (BECCS) (high confidence).

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I. INTRODUCTION

1) What is Biochar?

Biochar has been around for thousands of years, dating back to the pre- Columbian Amazonian natives between 450 BC to AD 950. Modern day researchers were fascinated by the dark, nutrient- rich soil that these Amazonian natives left behind. This Amazonian soil has since been referenced to as “Terra Preta,” which translates to black earth. 6 Biochar is produced using a technique called pyrolysis, in which biomass is heated in the absence of oxygen to temperatures between 300- 800 deg C. Biochar is a super charcoal made by heating any biomass – for example, corncob, husk or stalk, potato or soy hay, rice or wheat straw – without oxygen. All of the cellulose, lignin and other, non-carbon materials gasify and are burned away. What remains is pure carbon – 40% of the carbon originally contained in the biomass. Pyrolysis of biomass produces two primary byproducts: syngas and oil. Both byproducts can be used as fuel, providing clean, renewable energy. The syngas byproduct is a mixture of hydrogen, carbon dioxide, carbon monoxide and hydrocarbons.

2) Benefits of Making Biochar :

The carbon in biochar resists degradation and can hold carbon in soils for hundreds to thousands of years. Biochar is produced through pyrolysis or gasification — processes that heat biomass in the absence (or under reduction) of oxygen.In addition to creating a soil enhancer, sustainable biochar practices can produce oil and gas byproducts that can be used as fuel, providing clean, renewable energy. When the biochar is buried in the ground as a soil enhancer, the system can become “carbon negative.”The environmental benefits that biochar presents are potentially its greatest product value. The most significant environmental benefit is biochar’s ability to sequester carbon. Biochar and bioenergy co-production can help combat global climate change by displacing fossil fuel use and by sequestering carbon in stable soil carbon pools. It may also reduce emissions of nitrous oxide.The advantage of pyrolysization is that the sequestered carbon is retained in the newly formed biochar and is therefore not released back into the atmosphere. Research indicates that biochar can retain its carbon when buried in the ground for hundreds to thousands of years. We can use this simple, yet powerful, technology to reduce carbon emissions.The alternative – converting the waste into biochar instead of burning it removes three tons CO2 from the atmosphere for every ton produced; when added to fields as a soil amendment, that carbon is permanently sequestered as well as construction materials.The long term benefits of making biochar is a huge reduction of greenhouse gases that contribute to global warming.

3) Carbon Credit

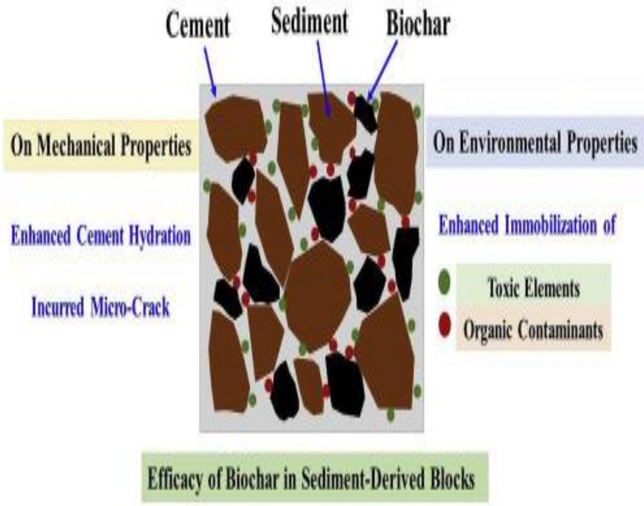
Biochar has carbon credit of participating in the very lucrative carbon offset market by IPCC in December 2020. Biochar is currently not recognized as an official method of producing carbon credits, although many researchers believe its entry into the carbon credit market is imminent. For this reason, the selling of carbon credits from biochar production will not be further explored in this feasibility study.

4) Biochar in Building Materials

Using biochar in building materials will reduce much of the greenhouse emissions and pollution caused by waste plastics, concrete, and organic waste. By sequestering the carbon from organic waste materials, biochar reduces the methane and carbon dioxide emissions released from landfill gas.Biochar is relatively well understood as a soil enhancement. Recently, it has been explored as a construction material. While works had been conducted on deploying biochar for road construction, there is an emerging trend of using biochar as concrete admixture. In comparison, using biochar this way will reduce more greenhouse gas emissions than if carbon is captured and sequestered through mineralization and deployment in construction. The use of biochar-containing construction materials to capture and then *lock* atmospheric carbon dioxide in buildings and structures can potentially reduce greenhouse gas emissions by an additional 25%. In this review, attention was focused on evaluating biochar's capability for carbon adsorption, which depends on factors such as pyrolysis conditions (specifically, pyrolysis temperature, heating rate, and pressure) and activation methods (and without surface modification). Gaps in the current literature were identified and important areas for future research proposed.

II. THEORETICAL BACKGROUND & ARTICLE SURVEY

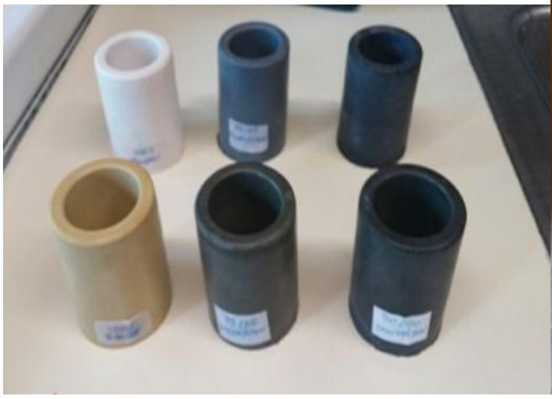
1) Cement and Concrete Composites



Routine navigational dredging generates huge quantities of marine sediment, posing significant environmental and economic burden. This research intended to explore the efficacy of wood waste biochar as a green admixture and assess the influence of different physico-chemical properties of dredged sediments on the mechanical performance of cement-based sediment products. X-ray diffraction and porosimetry analysis reflected that particle size distribution of sediments determined the pore structure formation and strength development. Thermal and calorimetry analyses showed that biochar incorporation slightly enhanced the cement hydration reaction, while its relatively large and brittle particles induced microcracks and weakened the strength of sediment products. Nevertheless, biochar addition enhanced immobilization of potentially toxic elements and organic contaminants, rendering the sediment products more environmentally acceptable. Hence, the innovative approach of this study can recycle dredged sediment and waste wood biochar to produce eco-friendly construction materials such as fill material and paving blocks.

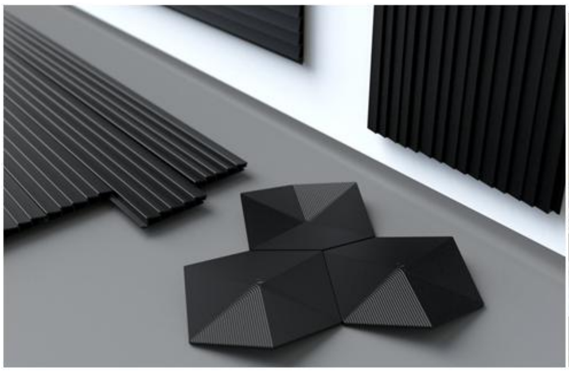
2) Carbonized Board

One approach to enhance the energy efficiency of buildings is the integration of construction materials of latent heat storage biocomposites, which are prepared by vacuum impregnating the phase change material into biochar. Biochar is used because it is highly utilized and environmentally-friendly, and the selected phase change materials are fatty acid type which are bio-based material and have a low risk of depletion. Experimental results showed that latent heat storage biocomposite possesses excellent exudation and thermal stability as characterized by 0.1727 W/mK of thermal conductivity comparable to that for a gypsum board, and good chemical compatibility as its amount of latent heat tends to decrease as compared with that of pure phase change material. Results of the numerical analysis showed further that latent heat storage biocomposite efficiently reduced the maximum energy consumption of reference building models by 531.31 kWh per year. Thus, both results validate the claim that latent heat storage biocomposite is a promising building material.




3) Biochar Plastic

In 2006, A company invented a material for buildings' façades that reduces urban air pollution and uses just sunlight to convert pollution into harmless substances. But it turned out to have a significant CO2 footprint. The built environment in general is the largest cause of embodied CO2. There's a lot of waste and a single contract can produce very high volumes. So they started looking into materials that would go beyond just "do no harm". If they could tweak something on the material scale, could they harness the sheer scale of construction to actually reverse climate change? A workable plastic would be a thermoplastic that you could put into a manufacturing process and press in different ways. After years of research, they established a prototype thermoplastic that is carbon-negative.




The solution is a replacement for durable plastics made from fossil fuels with a lifespan of 10-30 years. They start by creating biochar, which uses waste biomass from the agriculture industries. The plant material stores a lot of carbon dioxide. Instead of letting the plants decompose and release the CO2 back in the atmosphere, they bake them in an oven at a high temperature and keep the high-carbon char. It then goes through a series of refining steps and we mix it with a plant-based binder so they're able to drop it into typical plastics production channels such as injection molding. The end product is homogenous, doesn't really feel like a plastic but behaves like one. They have a family of compounds with different polymer bases that they can pick and choose for different applications depending on what's needed.The material is carbon-negative and depending on the ratio of binder to biochar, they can increase the carbon negativity. It's also an energy-positive process as burning the plant material releases heat. They're able to recover that heat and use it later in our supply chain for even more positive impact.

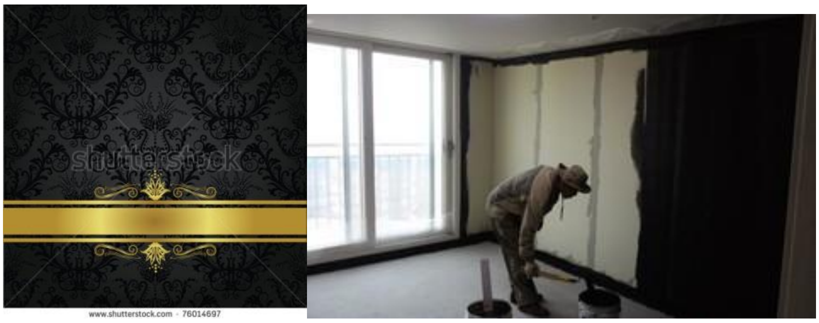
The material is a great replacement for plastics, aluminum, laminates and other composite materials used in buildings. The second market they're looking at is furniture, where there is an overuse of PVC, a toxic material we could help phase out. The third market is the automotive industry because car interiors have a lot of plastics in paneling and other components they could replace.

They are currently working with Audi to develop panels for one of their iconic dealerships' façade walls. They already delivered a pilot for them last year at Munich airport, testing how the material behaves in an external environment. The second pilot we are working on is in furniture, where theye are collaborating with a US-based volume furniture manufacturer to develop a carbon-negative chair. they are looking to mass produce the chair next year.Facade prototype at Audi facility.

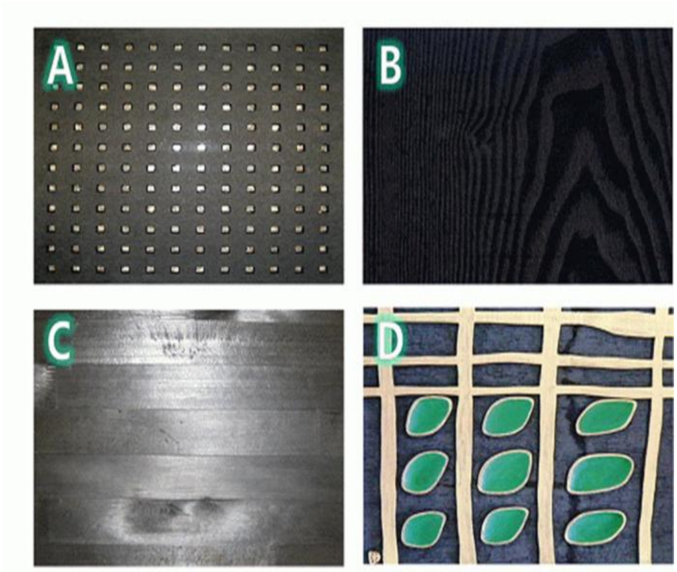
4) the others

- Paint blending with Biochar

- Wallpaper in Biochar



- Tile with Biochar

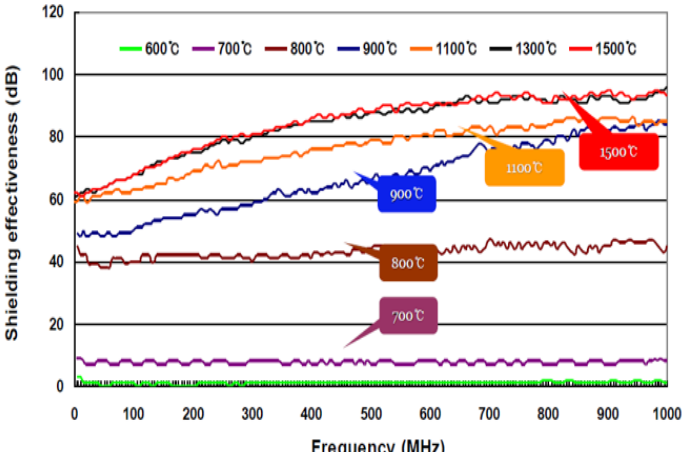


- Asphalt with Biochar : well-drained feature

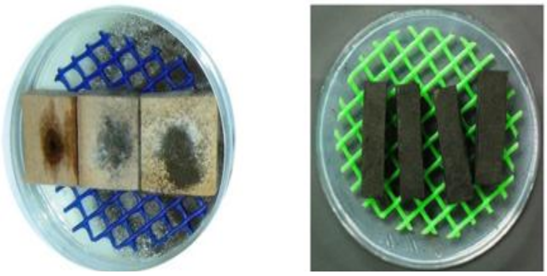
III. DISCUSSION

; Biochar Effects for Building Materials

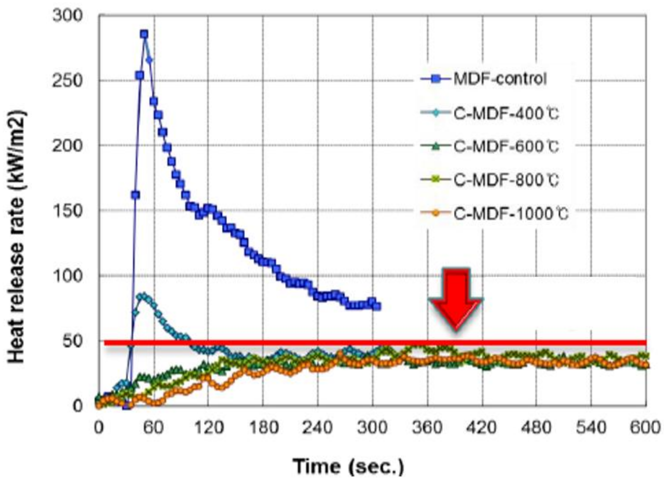
① E-wave blocking function: the temperature of carbonization is less than 800 degrees, but the electron wave blocking effect is small, but higher than 1,100 to 99.99%.



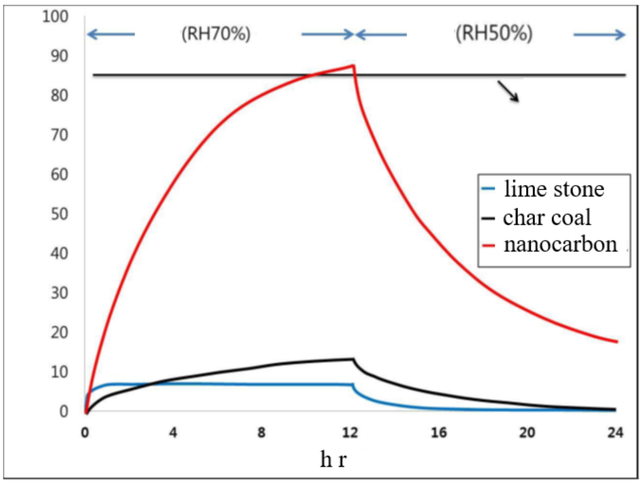
② Antimicrobial function : Large amount of mold generated in organic general wood, no mold generation on carbonized boards that are inorganic



③ Flame retardant function: Manufactured at high temperatures to meet flame retardant level 3, the total smoke emission is reduced by 90% during the carbonization process, so there are no smoke type accidents and no gas hazards.



④ Humidity control function: the humidity control performance of the carbonized board manufactured at 600 degrees is the best, passing through the best grade standard 85g / m 2 of functional building materials.



⑤ Formaldehyde removal function: The carbonized board is reduced by 70% depending
⑥ on the increase in the input water-based carbonization paint removes more than 90% formaldehyde.

Table 3. Adsorption of formaldehyde by wood charcoal-water paint

Wood charcoal content (%)	Total amounts of HCHO (μg)	Percentage of elimination (%)	Amounts of adsorbed HCHO (μg/g)
Initial Formaldehyde	8.76	-	-
Control*	5.86	33.11	0.58
15%	0.62	92.92	1.63
20%	0.58	93.38	1.64
25%	0.62	92.92	1.63

* Control: Water paint didn't contain wood charcoal.

$$HCHO(g) + O(a) \longrightarrow HCHOO(a) \quad (3)$$

$$HCHO(g) + OH(a) \longrightarrow HCOOH(a) + H^{+} + e^{-} \quad (4)$$

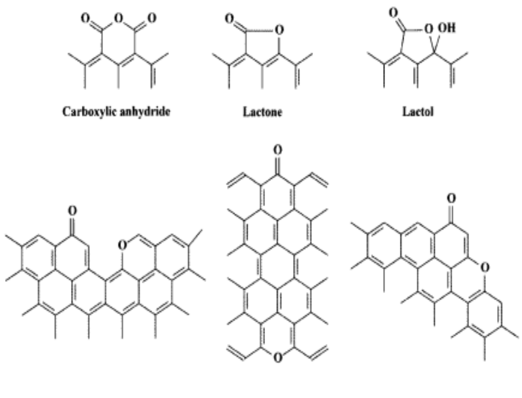


Fig. 2. Functional groups on the surface of carbonized materials (Boehm, 1994; 2002).

⑦ Radon reduction effect: the radon release is greatly reduced as the amount of biochar is increased, and the radon adsorption rate of the carbonized wood manufactured at 600 degrees is the highest.

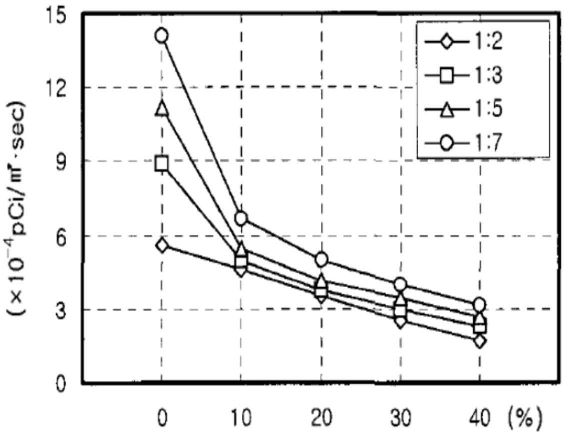
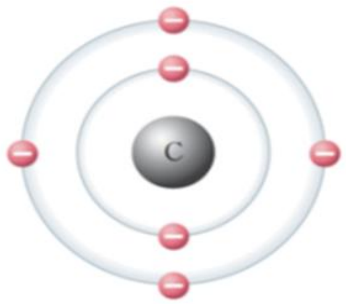
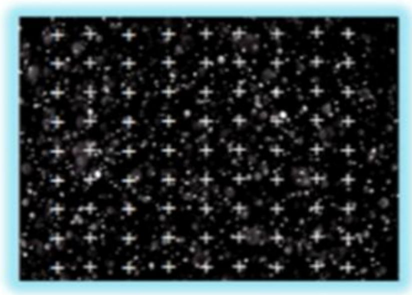


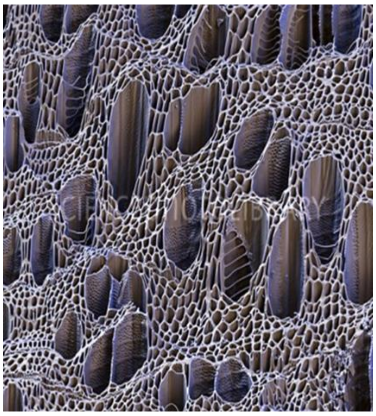
Fig. 9. Characteristics of Radon gas as adding carbon

Radon gas	Gypsum board (2kg, 0.36m2)	CP*1	*2ACP	CP	ACP	ACB*3	
		5mm		10mm		5mm	10mm
		p Ci/L (after 96hrs)					
Radon 222	13.97	3.96	2.59	2.32	2.08	2.43	2.46
Po 218	0.3	0.19	0.18	0.11	0.14	0.12	0.11

Finally. Fine dust adsorption function: in general, fine dust in the air is tinged with an amount (+) ions because it contains metal elements such as sulfates. Biochar is itself an electron (anion) mass consisting of carbon. Carbon is always preparing to receive cations with four negative (-) ion arms open. Biochar's anion function means that it is very reductive, and it is well known that it prevents the decay or oxidation of surrounding objects.







IV. CONCLUSIONS

1. According to the U.S. IBI or EU EBI, biochar production of 1 ton can contribute to carbon neutrality because it serves to fix carbon in buildings when used as a building material in the effect of reducing carbon dioxide from 1.8 tons to 3 tons. In addition, according to the research thesis examined above, when used in buildings by adsorbing toxic substances such as volatile organic compounds such as microwave blocking, formaldehyde, toluene, benzene, and radon has a good effect on people's health in various forms.
2. Comparing the carbon emissions for each building material of a house, the wooden house is 5,140 kg, the steel house is 14,740 kg, twice the wooden, and the reinforced concrete is 21,814 kg, which is 4.2 times the wooden.
3. The carbon emissions at the time of aluminum shot is 97kg and the carbon storage is 0kg, wood shot time is very environmentally friendly with 2.8kg, 5.6kg, respectively. Therefore, the environmental load is also very good at -2.8kg at the time of 97kg or wood shot aluminum shot.
4. Biochar, a wood or wood processing product, is a warehouse for storing carbon, which is the main cause of global warming, while fossil resources must mandate a green building system that uses more than 50% of wood or wood processing products for building construction in order to achieve 2050 carbon neutrality as a main crime of releasing carbon into the atmosphere.
5. Therefore, in order to realize the 2050 carbon neutrality, it seems that the project of developing and practicalizing building materials utilizing biochar, a carbon material, as much as efforts in the energy sector, such as the abolition of coal-fired power plants.

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