Biomanufactured Porous Carbon: A New Bioproduct

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Argonne NATIONAL LABORATORY

EMERGY LABS

BIO ECONOMY U.S. DEPARTMENT OF ENERGY 2017

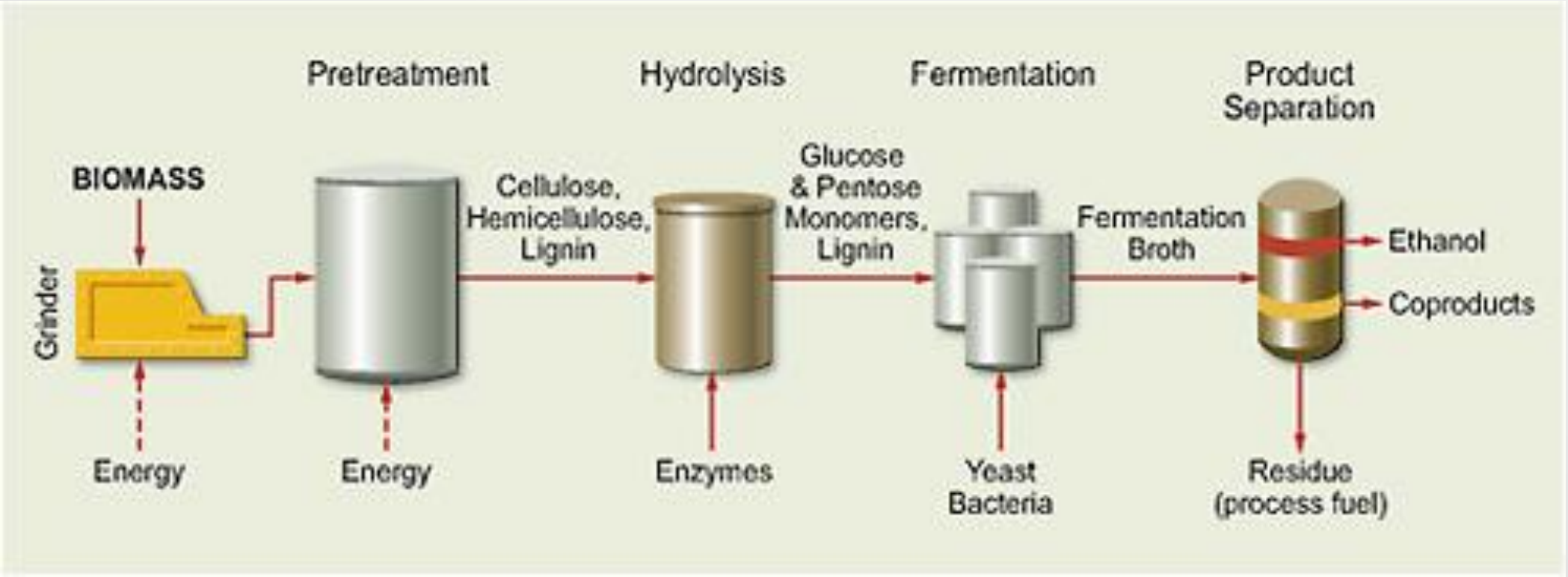
Bioproducts

Fuels

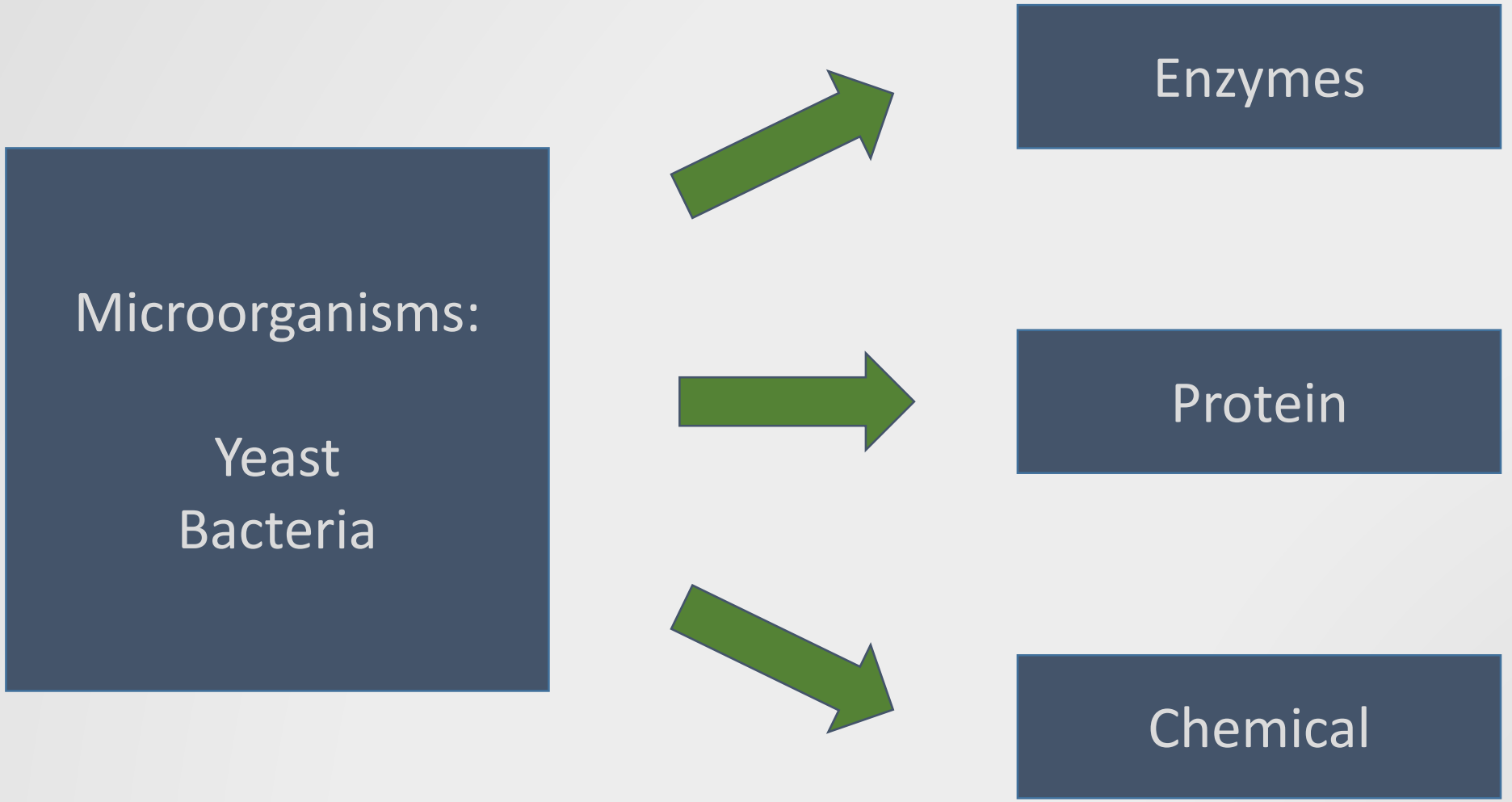
Energy

Materials

Biomaterials



Biomanufacturing



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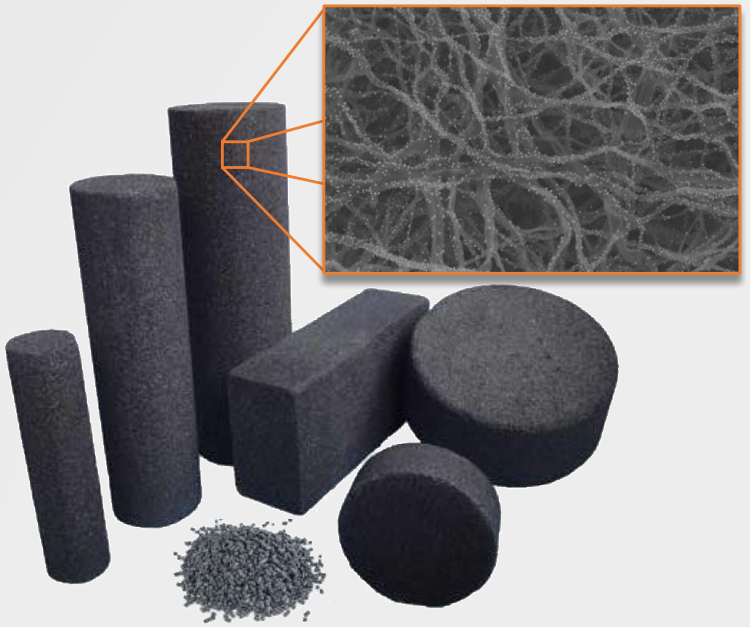
Micro-organisms



Energy Storage

Filtration

Chemical Production

Pre-revenue - materials company
Bottom-up approach for manufacturing porous carbon materials
Diverse application set with same manufacturing process

Activated Carbons

OLD

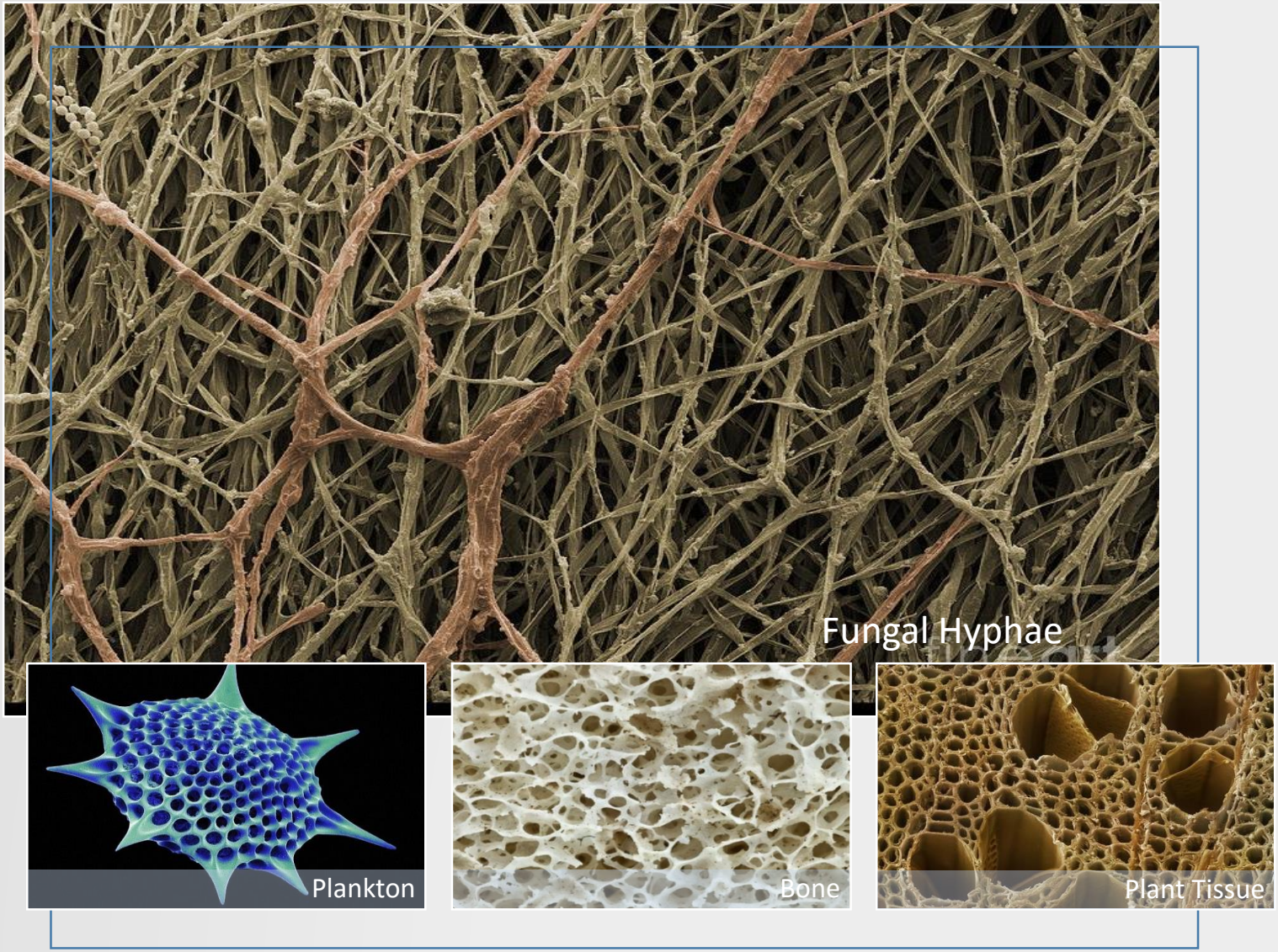
Coal

Wood

Coconut Shell

NEW

Inspiration from Nature



Biosynthesis of Materials

Highly sophisticated structures

Neutral pH - non-toxic

Abundant

Waste Sources as Carbons

Repeatable Feedstock

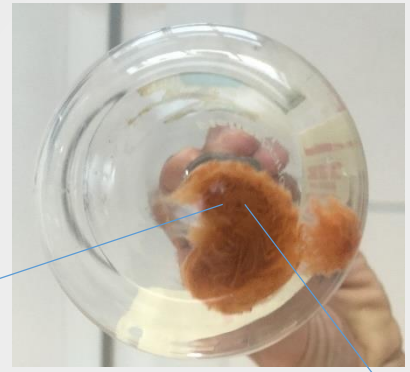
Proximity

Value

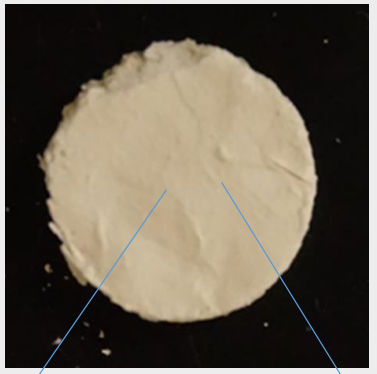
“Biological 3D Printer”

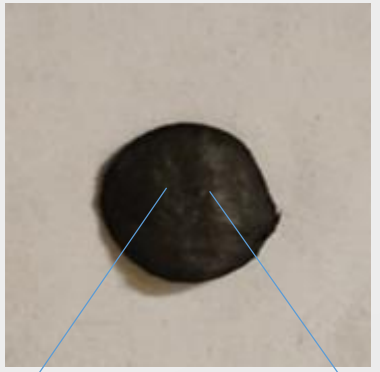
Filamentous Fungi

Controlled Cultivation

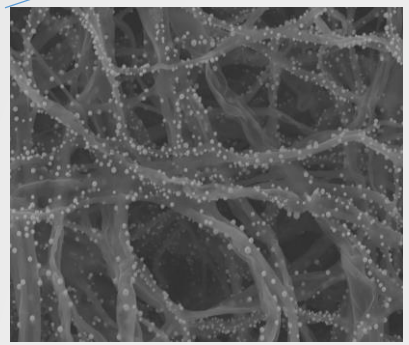


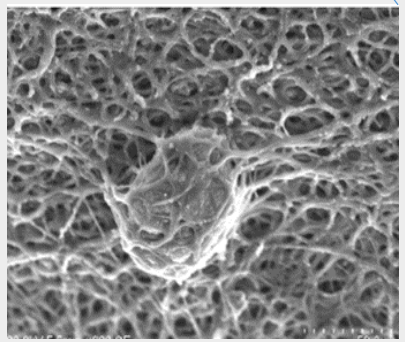
Thermal Conversion

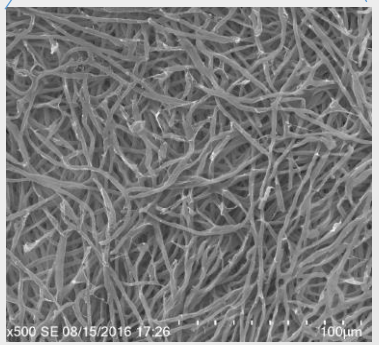


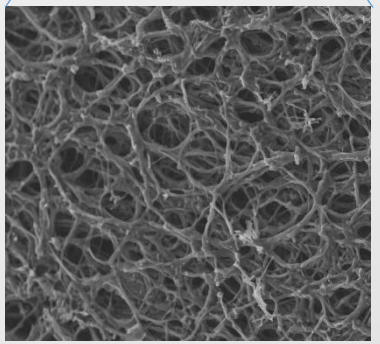


Chemical Properties

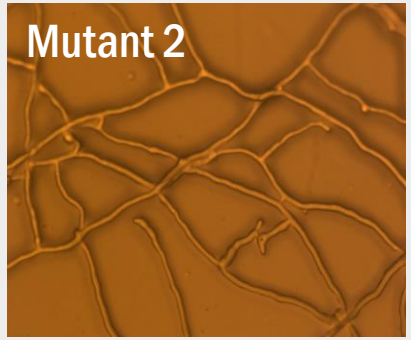








Physical Properties



Patent Pending Process

Increased Material Performance

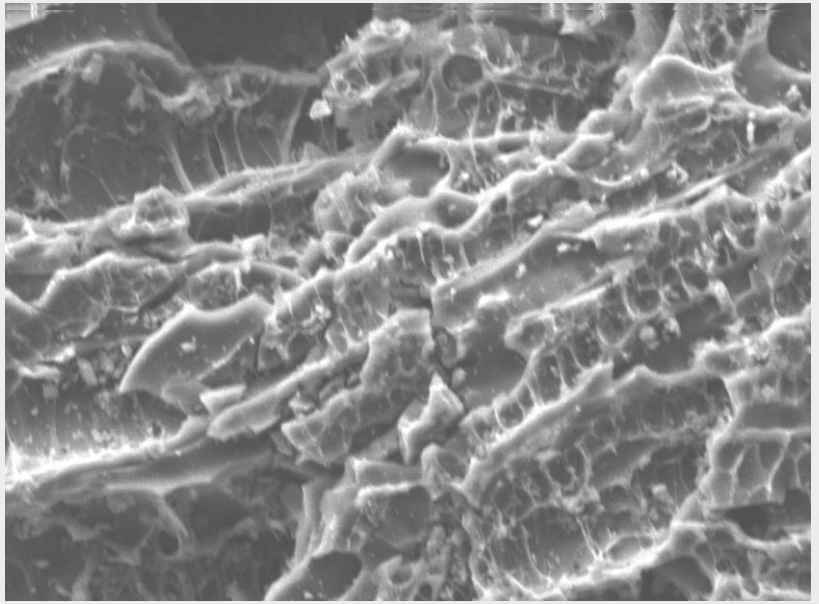
Improved

- Surface area
- Purity
- Hardness

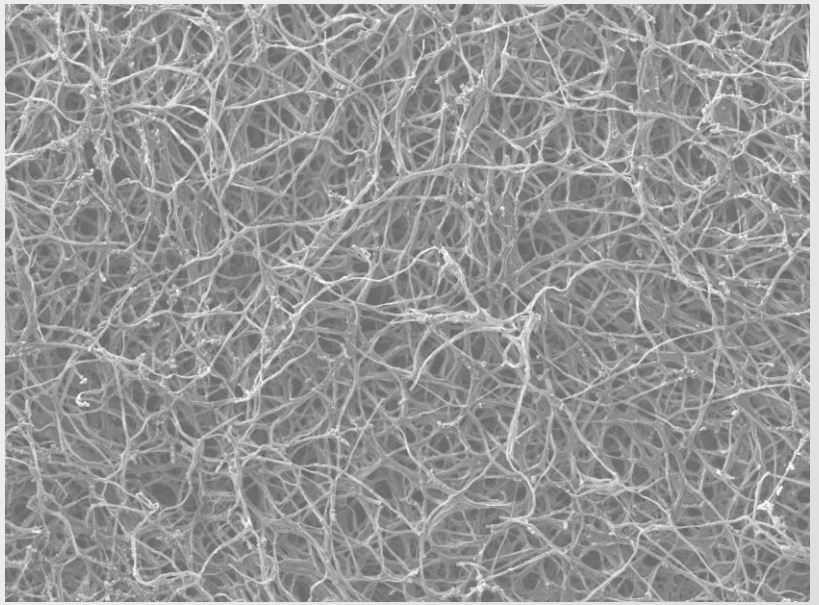
Benefit to industry

- Less amount of material
- Less capital and O&M costs

Competitor
“Surface usage”



Emergy
“Full volume usage”

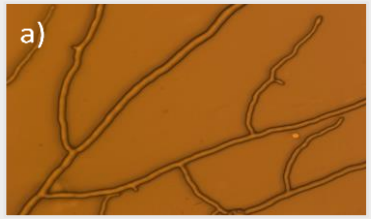


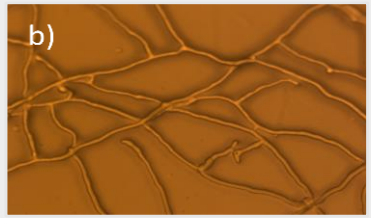
Product Comparison

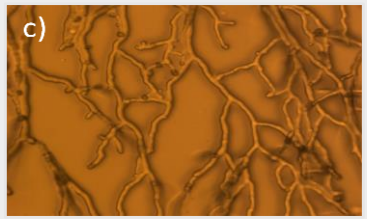
	Nanotube	Carbon Aerogel	Coconut GAC (High Purity)	Emergy Bio-carbons
Monolith	X	✓	X	✓
Integrate metals upfront	X	X	X	✓
Zero-cost Feedstock	X	X	X	✓
Industrial scalable	X	X	✓	✓
Porosity (m^2/g)	1500	1000	900	>2000
Price ($/kg)	~100	~300	10	8

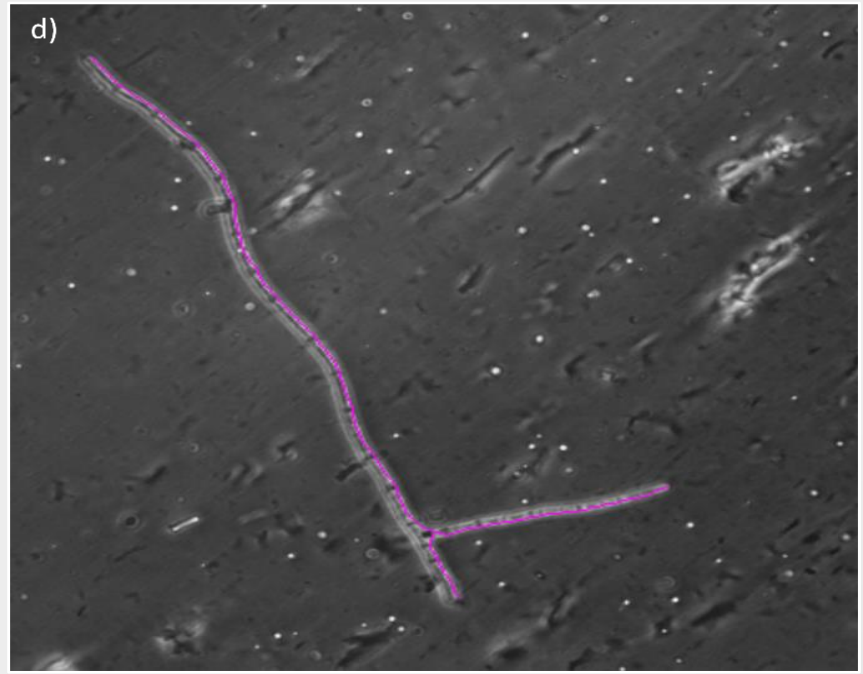
Tunable Material Properties

- Fully tunable
- Customized for application
- Increased performance









Carbon Material	Density (g cm^{-3})	V_{total} (cm^3)	V_{micro} (cm^3)	Specific BET Surface Area (m^2 g^{-1})	Volumetric BET Surface Area (m^2 cm^{-3})
Wild-3st	0.0765	0.0765	20.5	1870	143
4530-3st	0.0938	0.0938	23.1	1866	175
1372-3st	0.0846	0.0846	25.5	1990	168

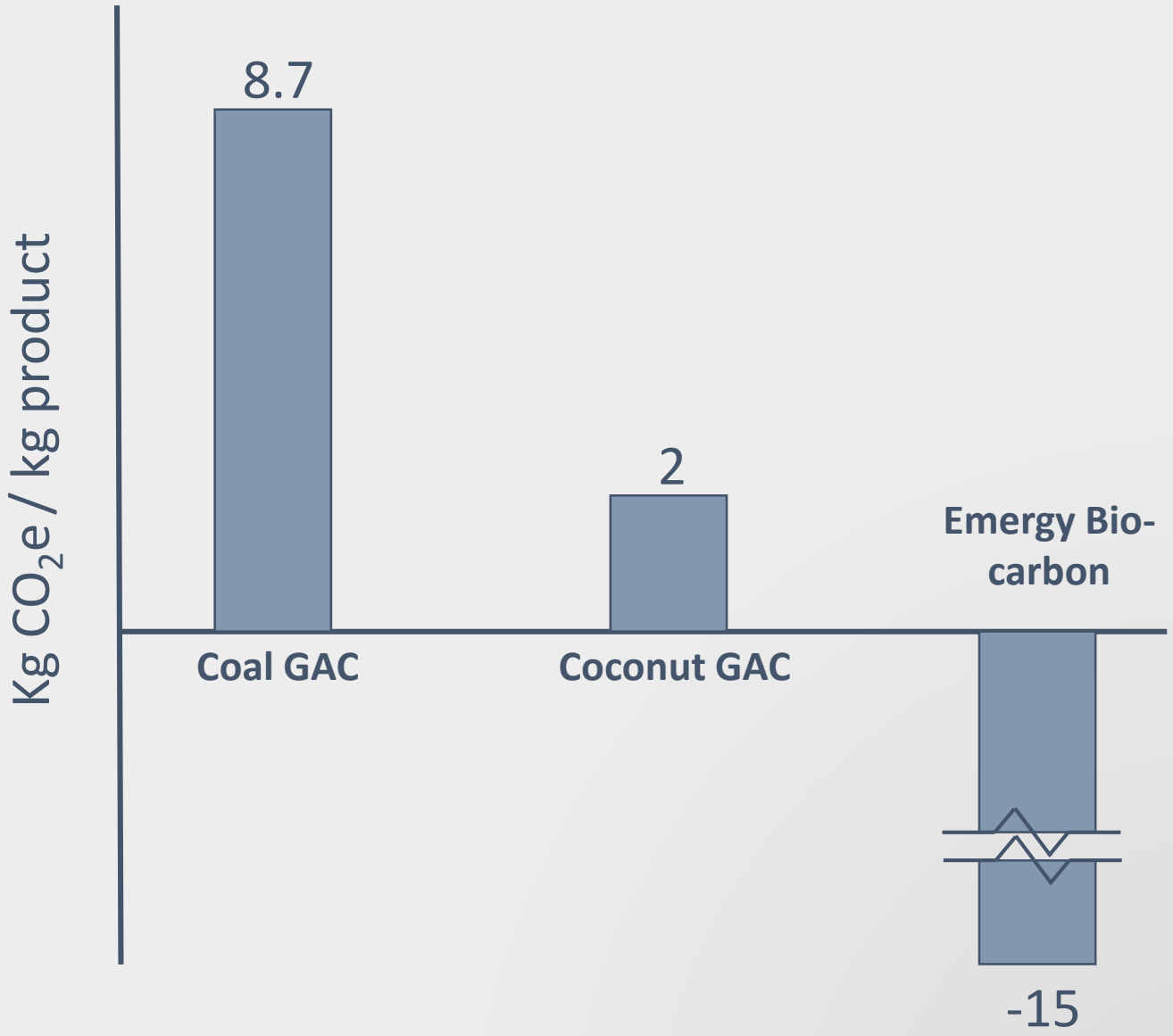
Product Applications

Sustainably Manufactured

- Carbon sequestration
- Waste utilization
- Low energy/resources

Benefit to industry

- Lower carbon footprint
- Reduced materials cost
- Good PR



Extraction

- Harvesting
- Washing
- Dewatering
- Shipping

Processing

- Molding
- Pyrolyzing
- Activating
- Pyrolyzing
- Activating
- Sieving
- Shipping

Forming

- Mixing
- Extrusion
- Drying
- Carbonizing
- Shipping

Application

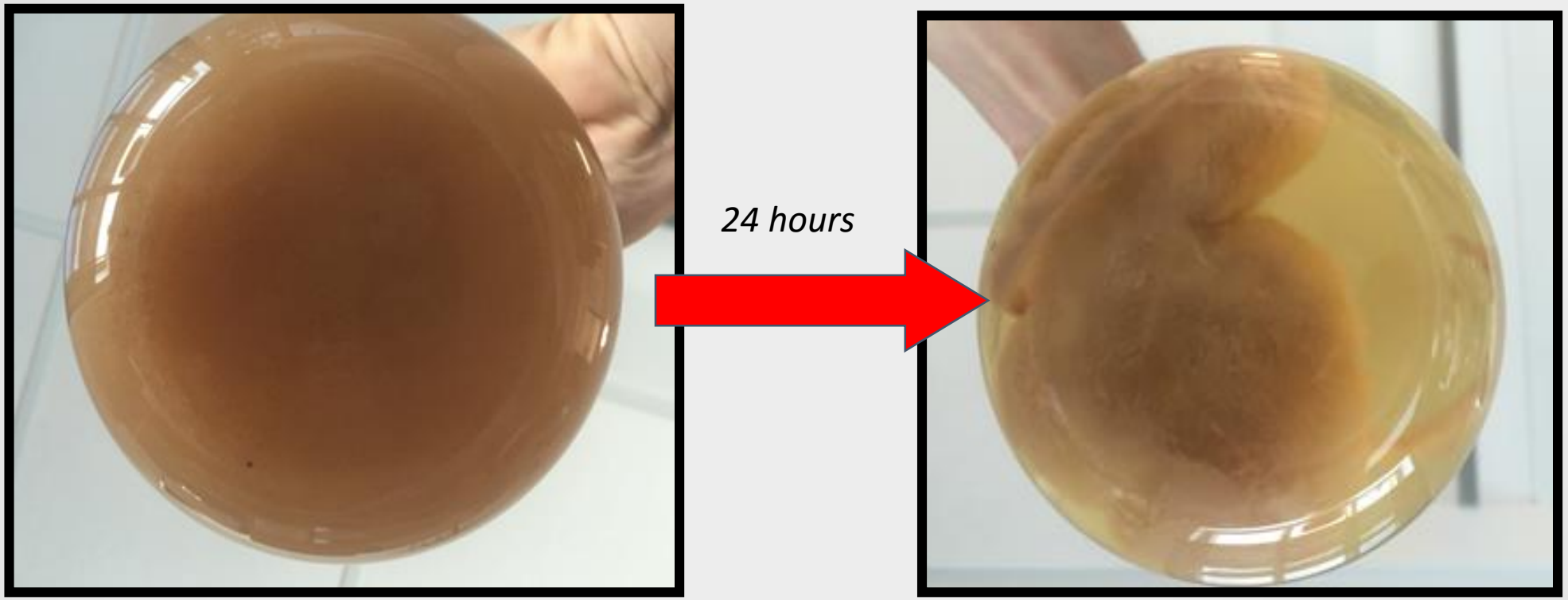
On-Site Production

- On-demand
- Reduced supply logistics
- Reduced transportation

Benefit to industry

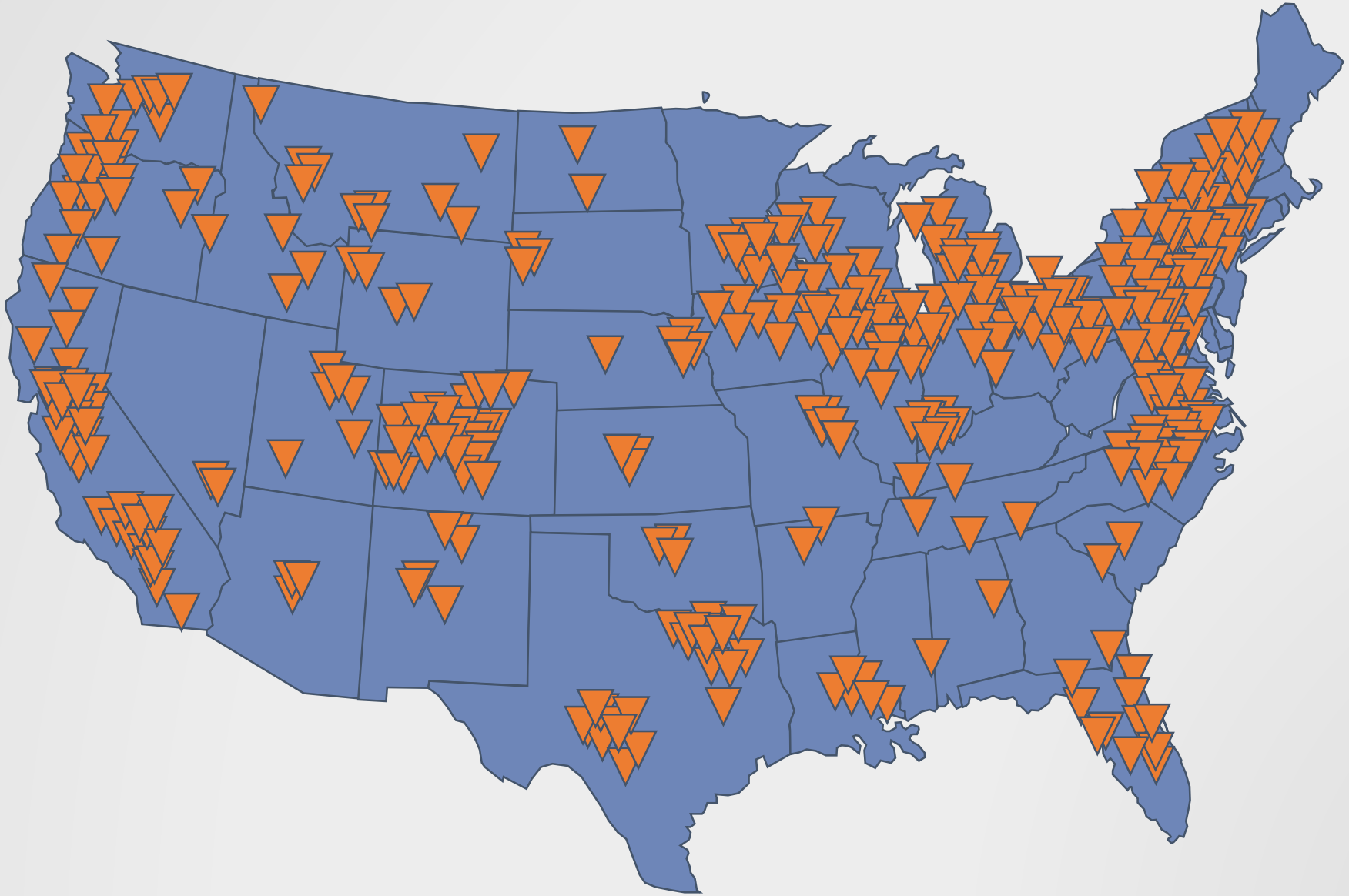
- Lower material costs
- No production delays

Brewery Wastewater Nutrient Source



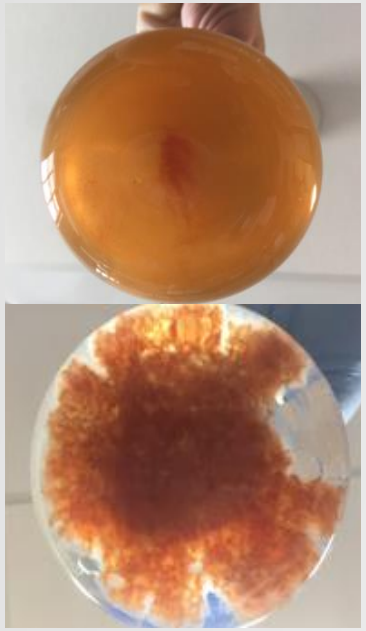
Distribution of Coconut Feedstock

Distribution of Wastewater Feedstock

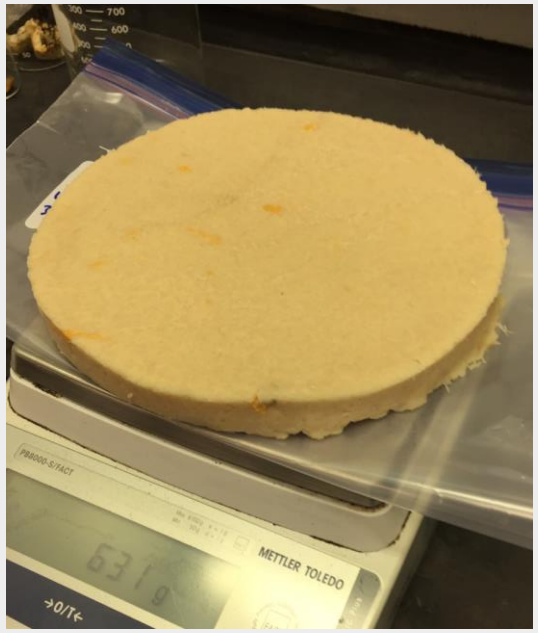


Integration into Bioeconomy

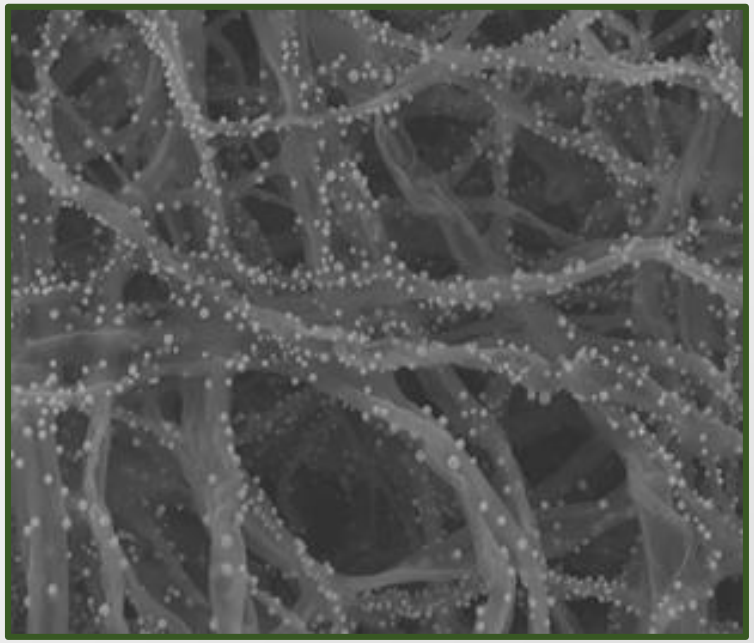
Waste utilization



Biology for Physical Properties



High Performance



Co-founders

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