Coal-Based Carbon Fibers A MARKET STUDY

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"There is no reason anyone would want a computer in their home."

> Ken Olsen founder of Digital Equipment Corporation, 1977



Market Background Research Methodology Market Potential Risk Mitigation

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Market Background

Key Points

- The cost of carbon fiber remains prohibitive for many applications.
- Alternative methods to create low-cost carbon fiber are available but under-utilized.
 - One such method is carbon fibers made from coal pitch.
 - Coal is abundant and inexpensive.
 - Infrastructures for coal mining and processing already exist.



Objective

What is the market potential for coal-based carbon fibers?

Our goal is to...

- Determine the possible applications
- Outline and define the market potential

Carbon Fiber Market

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The global carbon fiber market is projected to grow from USD 3.7 billion in 2020 to USD 8.9 billion by 2031, at a CAGR of 9.2% between 2020 and 2031.

Less than 2% of this market is currently pitch-based

Pitchler, D./PRNewsWire



Carbon Fiber Market

Applications by Market

		Sporting Goods (12%)	Automotive (10%)	Other (9%)
Wind Energy (23%)	Aerospace (20%)	Pressure Vessels (10%)	Compounding for Injection Molded Plastics (8%)	Construction & Infrastructure (8%)

Daniel Pitchler 6/4/2021

What is Coal-Based Carbon Fiber?

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Market Background **Research Methodology** ХŢ SX Market Potential -) Risk Miticjation

Market Summary **Potential Markets** Aerospace (Drone) Automotive Sporting Goods Construction **Focus Markets**

- Aerospace (Drone)
- Automotive

Use Cases

- (225) Total number of use cases
- (50) Researched use cases within drones and automotive that we have quantified
 - (20) Drone
 - (30) Automotive

Data Collection

Primary research:

- Utilize interviews from industry professionals
- Emailed 35 drone manufacturers

Secondary research:

- Published industry reports
- Internet websites
- Articles/journals

We used **225** use cases including military drones, commercial drones', and automotive applications.

Built a simple model to estimate market sizes.



Drone Market: Methodology



Industry	Product	Application Domain
Aerospace	Mini Drone	Agriculture

Year	Forecasted Production	Avg. Weight	% of CFRP	CFRP Weight per Unit	CF per Unit	Forecasted CF Weight	Forecasted CF Weight
2025	6,000	6.48 lbs.	60%	3.89 lbs.	1.17 lbs.	6,998.4 lbs.	3.50 tons

List of Use Cases.xlsx



Market Background Research Methodology Market Potential

Risk Mitigation

Drone Market

- Civil UAS expected growth to \$18.5B by 2029
- Civilian drones make up 83% of the market
- 6.05% annual growth for civil drone market





Automotive Market Forecast

- 1. A Pillar
- 2. B Pillar
- 3. Battery Case
- 4. Brake Caliper
- 5. Bumper Beam
- 6. CFRP Stabilization Bars
- 7. CFRP Wishbones
- 8. C-Pillar
- 9. Driveshafts
- 10.Skid Plate
- 11. Front Axel "Blade"
- 12. Front End Bolster
- **13. Front Engine Cover**
- 14. Front Fascia

- 15.Gear Cooler
- 16.Hood
- 17. Motor Castings
- 18. Output Shaft
- 19. Rear Deck Lids
- 20. Rear Fascia
- 21. Rear Suspension Knuckle
- 22. Rear Wall Panel
- 23. Seat Frame
- 24. Seat Rails
- 25. Seat Structure
- 26.Steering Knuckle
- 27. Suspension Knuckle

28.Suspension Links 29.Tailgate 30.Truck Pickup Box/Bed

30 Use Cases

633,566,687 lbs. of CF

316,783 short tons



Body in White











Automotive Market Calculation

Produc	ł	Classific	ation		Description				
Battery Co	ase	Serr Struct	ni- T ural	op of H	lybrid Battery	/ Case			
	Orig Mate	inal erial	Origi We	inal Uni eight	t CFRP %	CFI We	RP Unit eight		
	Alum	inum	20.4	46 lbs.	100%	11.3	37 lbs.		
Year	Forec	ast (x)	Qty p Vehi	oer cle	CFRP Gros	S	% of CF	CF Weight	CF Weight
2025	367	,855	1		4,181,281 lb	os.	30%	1,254,384 lbs.	627 tons
	Product Battery Co Year 2025	Product Battery Case Orig Mate Alum Year 2025 367	ProductClassificBattery CaseSem StructBattery CaseSem StructOriginal Material AluminumYearForecast (x)2025367,855	Product Classification Battery Case Semi-Structural T Structural Original Original Material Waterial Waterial Year Forecast (x) Qty notes to the second se	ProductClassificationBattery CaseSemi- StructuralTop of HOriginalOriginal Uni MaterialOriginal Uni Weight AluminumWeight 20.46 lbs.YearForecast (x)Qty per VehicleQty per Vehicle2025367,8551	Product Classification Description Battery Case Semi- Structural Top of Hybrid Battery Original Material Original Unit Weight CFRP % Aluminum 20.46 lbs. 100% Year Forecast (x) Qty per Vehicle CFRP Grost 2025 367,855 1 4,181,281 lb	Product Classification Description Battery Case Semi- Structural Top of Hybrid Battery Case Original Original Unit Weight CFRP % CFI Waterial Aluminum 20.46 lbs. 100% 11.3 Year Forecast (x) Qty per Vehicle CFRP Gross Weight 2025 367,855 1 4,181,281 lbs.	ProductClassificationDescriptionBattery CaseSemi- StructuralTop of Hybrid Battery CaseOriginal MaterialOriginal Unit WeightCFRP % Unit WeightAluminum20.46 lbs.100%11.37 lbs.YearForecast (x)Qty per VehicleCFRP Gross Weight% of CF 30%2025367,85514,181,281 lbs.30%	ProductClassificationDescriptionBattery CaseSemi- StructuralTop of Hybrid Battery CaseOriginal MaterialOriginal Unit WeightCFRP % WeightAluminum20.46 lbs.100%YearForecast (x)Qty per VehicleCFRP Gross Weight% of CF Weight2025367,85514,181,281 lbs.

List of Use Cases.xlsx



Automotive

- Manufacturers want lighter weight vehicles
- Carbon Fiber in Automotive Market will grow 19.84% from 2020 to 2024.





Realistic Scenarios

Classification	CF Weight
Non-structural	117,961 tons
Semi-Structural	52,611 tons
Structural	146,789 tons

Brand	CF Weight
Toyota	90,028 tons
Chevy	78,248 tons
Ford	74,339 tons
Dodge	56,740 tons
Honda	56,604 tons
GMC	21,116 tons
Tesla 3	15,930 tons



Market Background Research Methodology Market Potential **Risk Mitigation**





Risk Prioritization







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