# High-Modulus Carbon Fiber from Coal Pitch

Business Plan

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## Executive Summary

### Product

Carbon fiber has become a major player in the composites industry due to its high strength-to-weight ratio and its high elastic modulus. Unfortunately, traditional PAN-based carbon fiber is prohibitively expensive for many applications. Using established processes, cheaper carbon fiber can be produced from coal pitch. While the coal-pitch-based carbon fiber is cheaper, it has different yet valuable material properties including an ultra-high elastic modulus, a property consumers would generally refer to as stiffness or rigidity.

### Customers

Carbon fiber made from coal pitch has several potential markets, including:

1. Existing carbon fiber markets that use carbon fiber for its stiffness rather than its strength;
2. Non-structural and semi-structural aerospace applications and other applications for which carbon fiber is being (or could be) used for its light weight rather than its strength;
3. Non-existing markets that would leverage pitch-based carbon fiber for its stiffness or its thermal or electronic properties.

The Department of Defense, in particular, has a pressing need for lower-cost carbon fiber in aerospace applications.

### Future of the Product

Carbon fiber from coal pitch possesses unique material properties (*e.g.*, stiffness) that make it a more sustainable product than PAN-based carbon fiber. This is because PAN-based carbon fibers face competition from other fibers such as polybenzoxazole (PBO) fibers (*e.g.*, Zylon®) that exhibit similar strength and stiffness but do not need to be baked at very high temperatures. While PBO fibers outperform PAN-based carbon fiber in many dimensions, no existing light-weight product can compete in stiffness with carbon fiber produced from coal pitch. Unfortunately, an entrant into the coal-pitch-based carbon fiber market may still experience a shock if PAN-based fibers are displaced by synthetic fibers such as PBO, because in this case, existing PAN-based carbon fiber production facilities may switch to pitch-based carbon fiber.

## Company Description

### Purpose

To manufacture and sell carbon fiber made from mesophase pitch.

**Current Stakeholder Organizations and Contributors**

Utah Defense Manufacturing Community (UDMC)

Utah Advanced Materials and Manufacturing Initiative (UAMMI)

Weber State University, Advanced Research and Solutions Center

Weber State University, College of Engineering, Applied Sciences and Technology

Weber State University, Goddard School of Business and Economics

Seven Counties Infrastructure Coalition

## Market Research

### Industry

The producer of the proposed carbon fiber from coal pitch will be a member of the advanced materials and composites industry. The only key player producing high-modulus carbon fiber from coal pitch currently is Mitsubishi Chemical with their DIALEAD™ product line. Other carbon fiber manufacturers (*e.g.*, Solvay, Nippon Steel) have oil-pitch-based carbon fiber products with similar material properties. Since pitch-based carbon fibers have such unique properties and a lower cost than traditional PAN-based carbon fiber, a significant and sustainable market is expected to continue to grow.

Even though the pitch-based carbon fiber occupies a unique and valuable position in the composites realm, it is possible that innovation will introduce additional synthetic fibers that surpass traditional PAN-based carbon fiber in its most valuable material properties. If PAN-based carbon fiber begins to be displaced from its current markets, existing PAN-based carbon fiber production lines may be converted into oil- and coal-pitch-based lines. Such line conversion would present a significant risk to early entrants into the pitch-based carbon fiber market.

### Detailed Description of Customers

The expected use of pitch-based carbon fiber is as a lightweight rigid composite material with good tensile strength. Customers will be parts manufacturers for applications in which gravity represents a very significant cost or pain point. If high rigidity is also preferred in the application, it is very well suited to pitch-based carbon fiber. Examples include non-structural and semi-structural parts used in vehicles of air travel, ground transportation in hilly or mountainous terrain, and oceanic transportation. In addition, structural elements for which the design constraint is the elastic modulus are excellent candidates for replacement with coal-pitch-based carbon fiber.

## Product Line

### Products

The coal-pitch-based carbon fiber manufacturer could potentially have a line capable of producing multiple products with increasing elastic modulus, similar to Mitsubishi’s DIALEAD™ product line and Solvay’s oil-based-pitch “P” line of carbon fiber products. Material characteristics would depend on process operating parameters, with higher-modulus fibers produced from processing conditions with higher operating costs.

### Pricing Structure

The company needs to maintain a minimum average price of around $12 per pound of carbon fiber product to maintain financial attractiveness to investors, giving an IRR of around 20%. Until a more competitive market is established, much higher prices could be charged to quickly recuperate up-front capital investment. However, prices too high could discourage adoption by new markets. Assuming production at annual capacity and a price per pound of $12, the net present value of the facility is close to $50 million (assuming an interest rate of 9.3%).

### Intellectual Property Rights

Several production technologies are available to be licensed to improve the quality, yield, and cost of the production process. Such technologies should be further investigated.

## Strategy

### Launch and Growth Strategy

A startup would be a risky venture in this industry at this time. However, a new venture would be possible with a guaranteed customer. A likely customer would be the Department of Defense or a company in the defense industry.

### Startup Financing

Ideally, the funds to build the carbon fiber manufacturing facility will come from a combination of private, banking, and public sources. Public funding is limited to real estate and other tangible items that would continue to hold value even if process operations are halted. Because of the uncertainty surrounding availability of public funding, however, this business plan makes the most conservative assumption that no public funding will be available. Thus, the startup costs used in the business case analysis are close to a worst-case scenario. The business case analysis used for the economics presented here assumed that private funds account for 25% of the startup costs while loans account for the remainder. In the situation that the investors can get a favorable interest rate, the IRR on the investor’s up-front costs (*i.e.*, 25% of the total up-front costs of $121 million) is above 100%.