Carbon Fibre Grand Challenge
Phase II Webinar

Dr. Paolo Bomben, Senior Manager – Clean Technology Development
Bryan Helfenbaum, Executive Director – Advanced Hydrocarbons

March 23, 2021
AGENDA

• Submitting Webinar Questions
• Background on Alberta Innovates & CRIN
• Bitumen Beyond Combustion
• Asphaltenes & Their Properties
• Grand Challenge Objectives & Program Details
• Application Process
• Evaluation Criteria
• FAQs
• Q&A
Housekeeping – Submitting Questions (via Teams Live)

1. Click on the message box in the Live event Q&A tab
2. Type in the message you would like to send
Alberta Innovates At A Glance

- Largest provincial R&I agency in Canada ($180M/year)
- Innovation strategy and programs
- Provide technical expertise, entrepreneurial advice
- Provide funding to advance innovation

Business Lines
- Clean Resources
- Health Innovation
- Investments + Emerging Tech

Storied History of Supporting Innovation
- Oilsands (BPU, BBC)
- Materials (MARIOS)
- Wood Products (OSB)
- Artificial Intelligence / Machine Learning (Amii)
- Agriculture (CAAIN)

Subsidiaries
- C-FER Technologies
- InnoTech Alberta
ALBERTA RESEARCH AND INNOVATION FRAMEWORK (ARIF) | 2030 TARGETS

ENERGY AND GHG MITIGATION

- **45%** reduction in methane emissions by 2025
- **30%** electricity from renewables
- **50%** per bbl decrease in fresh water use and GHG emissions
- **25%** increase in value of oil and gas exports

ENVIRONMENT AND CLIMATE ADAPTATION

- **30%** increase in water efficiency and safe, secure water
- **20%** reduction in landscape disturbance and accelerated reclamation

EMERGING TECHNOLOGIES

- **25%** Revenue increase in cleantech
- **$40B** Alberta’s manufacturing output
- **$20B** Alberta’s digital economy

BIOINDUSTRIAL

- **50%** reduction in waste to produce new products
- **$3B** drive investment into advanced bio-products, fuels and bio-energy
- **$3$$** Biodiversity maintained or enhanced

ALBERTA INNOVATES
Clean Resources Program Areas

- Advanced Hydrocarbons
  - Recovery
  - BPU
  - BBC
  - DICE
- Clean Technology
  - Smart Grid
  - Bio-Fuels
  - CCUS
  - H₂, Li, V, etc.
- Environmental Innovation
  - Water
  - Land
  - Tailings
  - Biodiversity
- Smart Agriculture and Food
  - DNA Tools
  - Big Data
  - Automation
- Bio-Industrial Materials
  - Alberta Aspen Initiative
- Alberta Prion Research Institute
  - BSE
  - CWD

Support to ERA
- Strategic Advice
- Project Adjudication
- Project Advisory
Diversity, Equity, Inclusivity

• We believe the Alberta Research and Innovation (R&I) ecosystem is stronger and more sustainable when it is broadly representative of the overall diversity of our community.
• We strive to ensure that all interested and qualified parties have an equitable opportunity to participate and contribute to the ecosystem and that our processes are inclusive.
• Historically, there have been a number of groups/populations that have been under-represented in the R&I landscape including:
  • Women entrepreneurs/researchers
  • Indigenous entrepreneurs/researchers
  • Remote/small community entrepreneurs/researchers
  • New immigrant entrepreneurs/researchers
• We encourage ALL entrepreneurs/researchers to apply!
• If you are a first time AI applicant, don’t hesitate to reach out to the program contacts for navigation information.
CRIN

• Vision: To contribute to a future in which Canada is the global leader in producing clean hydrocarbons from source to end use

• > 1300 Member organizations

• “Network of Networks”

• 7 Theme areas including Low Emissions Value Added Products (LEVAP)

• Funded by Innovation, Science, and Economic Development (ISED) Strategic Innovation Fund (SIF)

• Funding partner for Phase II of the CFGC
BACKGROUND
Alberta Oilsands Bitumen

- Reserves: 180 Billion bbl
- Production: 3 Million bpd

Combustion Products (~90%)

Non-combustion Products (~10%)

- Non-combustion products are produced by refineries (e.g. lubricants, etc.)
Bitumen Beyond Combustion (BBC)

What is BBC?

• BBC involves the conversion of bitumen to non-combustion materials instead of using bitumen as a source for transportation fuels

• Asphaltene, the heaviest component in bitumen, holds the best promise for BBC

• 15 - 20% of the barrel is asphaltenes

• Carbon fiber is identified as a top BBC product

Bitumen and Asphaltene → Process Technologies → Carbon fibre (CF) → Asphalts → Activated carbon → Vanadium flow battery → Metal carbides & graphene

Alberta Innovates
Bitumen Beyond Combustion (BBC)

Objectives of BBC

• Economic development
• Job creation
• Greenhouse Gas Reduction
• Resource Protection
• Diversification
Carbon Fibres: Example Production from Asphaltenes

**Advantages**
- Favourable chemistry
- Low cost supply
- Divert hydrocarbons away from combustion

**Challenges**
- Stabilization
- Pre-treatment necessary
- Sulfur and metal content
- Scale-up
- Carbon efficiency & GHGs
- Don’t know what we don’t know

**Opportunity for Innovation!**
What Are Asphaltenes?

• Solubility fraction of petroleum (including bitumen): insoluble in n-alkanes; soluble in toluene
• Polydisperse complex mixture
  • MW from ~400 to 1,000 Da
  • Wide range of molecular types
  • 78-80 wt % carbon; range of H, S, O, N per molecule
• Glassy solid at room temperature
• Thermoplastic; softening at 120 – 230°C depending on composition and treatment
• NOT petroleum pitch
What Are Asphaltenes?

80-90 wt% bridged structures
Strong aggregation

10-20 wt% island structures
Weak aggregation

## Carbon Fibre: Production

<table>
<thead>
<tr>
<th>Carbon Fibre Production</th>
<th>From PAN &amp; Pitch (Current)</th>
<th>From Asphaltenes (Target)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost, US$/kg</td>
<td>18 – 35</td>
<td>&lt; 9</td>
</tr>
<tr>
<td>Global production, tpy&lt;sup&gt;a&lt;/sup&gt;</td>
<td>100,000</td>
<td>400,000&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> requires approximately 100,000 barrels per day of bitumen
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Grand Challenge Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geometry</td>
<td>diameter: 7 ( \mu \text{m} ), length: continuous or 6 mm</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>( &gt;3,000^a - &gt;4,000^b ) MPa</td>
</tr>
<tr>
<td>Modulus</td>
<td>( &gt;250^a - &gt;300^b ) GPa</td>
</tr>
</tbody>
</table>

\( ^a \) Phase II  \( ^b \) Phase III
## Current Target Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Grand Challenge Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geometry</td>
<td></td>
</tr>
<tr>
<td>Diameter</td>
<td>7 μm</td>
</tr>
<tr>
<td>Length</td>
<td>Continuous or 6 mm</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>&gt;3,000&lt;sup&gt;a&lt;/sup&gt; - &gt;4,000&lt;sup&gt;b&lt;/sup&gt; MPa</td>
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<td>&gt;250&lt;sup&gt;a&lt;/sup&gt; - &gt;300&lt;sup&gt;b&lt;/sup&gt; GPa</td>
</tr>
</tbody>
</table>

<sup>a</sup> Phase II  
<sup>b</sup> Phase III

- Driven by commercial needs – other property combinations are accepted in Phase II as long as there is a demonstrated commercial need.
Key Knowledge Gaps: Carbon Fibre Production from Alberta Oilsands Asphaltenes

• Mesophase Requirement
• Sulphur and Metals Treatment
• Scientific Fundamentals
• Short Carbon Fibre Production
• Large-Scale Production
• Economics, Energy Requirements and Greenhouse Gas Emissions
GRAND CHALLENGE PROGRAM DETAILS
Objectives

• Greatly accelerate the development of technologies that can convert Alberta Oilsands Asphaltenes (‘AOA’) into carbon fibre
• Create line of sight to production capacities and costs that would enable rapid uptake of carbon fibre into major existing and new markets
• Advance technologies that will benefit industry in Alberta and Canada
# Grand Challenge Timeline

<table>
<thead>
<tr>
<th>Date</th>
<th>Planned Activity</th>
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<tbody>
<tr>
<td>January 2020</td>
<td>Launch of Grand Challenge (COMPLETED)</td>
</tr>
<tr>
<td>January – April 2020</td>
<td>Phase I Application process (COMPLETED)</td>
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<tr>
<td>June – February 2021</td>
<td>Phase I Projects execution (COMPLETED)</td>
</tr>
<tr>
<td>February – April 2021</td>
<td>Phase II Application process (IN PROGRESS)</td>
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<tr>
<td>June/July 2021 – December 2022</td>
<td>Phase II Projects execution</td>
</tr>
<tr>
<td>January – February 2023</td>
<td>Phase III Registration</td>
</tr>
<tr>
<td>March 2023 – December 2024</td>
<td>Phase III Execution</td>
</tr>
</tbody>
</table>
Phase II – Scaling

• **Goal:** consolidate learnings from Phase I to produce carbon fibre from AOA at lab scale, with properties desired by commercial end-users; and to develop a process with line of sight to a demonstration plant that can be commercially scaled.

• **Applicant Objective:** produce CF that meets minimum quality specifications desired by commercial end users, using bitumen-derived AOA and develop a pathway to managing the sulfur and metal content from the asphaltenes.
Phase II – Scaling

• **Targeted Outcome:**
  • Carbon fibre production of > 10 grams per day with tensile strength >3,000 MPa and modulus >250 GPa or other strength/modulus combination that meets a demonstrated commercial need;
  • Potential end uses identified and/or validated
  • if short fibres are the project focus in Phase II the target length is 6 mm with 7 µm diameter or other length/diameter combination that meets a demonstrated commercial need;
  • preliminary energy requirements for the proposed CF manufacturing process and corresponding greenhouse gas emissions profile;
  • preliminary cost expectations for carbon fibres manufactured using the process developed in Phase II.
Phase II – Scaling

• **Funding:** $200,001 up to $500,000 CAD awarded to successful applicants. A total of $5,000,000 is available.

• **Matching Funds:**
  - 50% of the total eligible costs is the target for the project, however, consideration will be given to applications with less than 50% matching funds
  - Overhead will be considered as an in-kind contribution for up to a maximum of 30% of the total budget

• **Application Deadline:** April 27, 2021 at 2:00 PM MDT
PHASE II APPLICATION
Eligibility

Applicants

• Open to technology developers, industry (including small, medium, and large size enterprises), industry associations, research and development (R&D) organizations, post-secondary institutions, not-for-profit organizations, and government research labs.

• Applicants are not required to be based in Alberta or Canada but must demonstrate a clear value proposition to Alberta and Canada
Eligibility

Applicants

• Must have demonstrated expertise with respect to:
  • Applying scientific and engineering fundamentals relevant to the manufacture of carbon fibre
  • Completing scientific or technical laboratory or other small scale practical work on or relevant to carbon fibre production
  • Utilizing results and conclusions from laboratory and other small-scale work to establish the viability and competitiveness of production technologies, such ability to include experience with preparing process flowsheets (with mass and energy information and basic equipment specifications) for purposes of process evaluation and scale-up;
  • Identifying and addressing critical business issues, including CAPEX and OPEX estimates, market characteristics, and environmental and social acceptance;
  • Addressing scientific, technical, business, and environmental challenges and opportunities.
Eligibility

Project Partners (if any)

• Project Partners must satisfy the following criteria:
  • demonstrate the relationship between the Applicant and the Project Partner(s) does not create a conflict of interest;
  • be in good financial standing with Alberta Innovates and its subsidiaries InnoTech Alberta and C-Fer Technologies;
• Other Funding Agencies are considered eligible partners
Eligibility – International Researchers

Export Controlled Substance

- Carbon Fibre may be a controlled material governed by the Applicant country’s national export control laws.

- The Applicant will be required to report, in a confidential manner, technical details regarding the testing methods and manufacturing processes related to the carbon fibre developed in the Applicant’s project.

- Export control regulations and/or failure to obtain an export clearance (to the extent required) do not absolve the Applicant from the responsibility of reporting on technical details in a confidential manner and providing a sample to Alberta Innovates (and the Alberta Government who is Alberta Innovates’ sole shareholder).
Asphaltene Samples

• Asphaltenes used in Projects funded by the Grand Challenge must be derived from Alberta oilsands bitumen. **No exceptions will be made.**

• Alberta Innovates can provide samples through our Asphaltene Sample Bank

• Applicants can select which samples they would like to use based on the sample properties is available on the CFGC website

• All samples in the sample bank offered as part of Phase II of the Carbon Fibre Grand Challenge have the potential to form carbon fibre, although the processing prior to carbon fibre manufacture may differ from sample to sample.
Application Evaluation Criteria

• Innovation Opportunity
• Market Opportunity
• Proposed Commercialization Pathway
• Project Overview and Work Plan
• Budget
• Team
• Project Risk Analysis
• Impacts – Alberta & Canada Implementation Plan
Phase II Application Process

- Online application portal (http://albertainnovates.smartsimple.ca)
- One-stage application
- **Deadline is April 27, 2021 at 2:00 PM MDT**
Online Portal Instructions

• Step 1: Register
• Step 2: Select the correct application (Carbon Fibre Grand Challenge)
• Step 3: Fill out the application
• Step 4: Submit
Online Portal Instructions

• Step 1: Register

Registration

I am a representative of an:

Academic Institution - Alberta

Academic Institution - Other

For-Profit Organization - SME

For-Profit Organization - Other

Government Entity - Alberta and Affiliates

Government Entity - Other

Non-Profit/Not-for-Profit Organization

What should I choose?

The Applicant on your Application will be the organization you are representing. If you are representing multiple organizations, you will need to sign up individually for each organization you represent. Please note, at this time we do not have any programs geared towards individuals/sole proprietors, so you cannot register as one of these.

The following will help you understand which organization you are representing. Please follow the statement that matches you best. For more information or questions, please contact inbox_grants@albertainnovates.ca.

I am with an Academic Institution within the Province of Alberta
- Register with Academic Institution - Alberta

I am with an Academic Institution outside the Province of Alberta
- Register with Academic Institution - Other
Online Portal Instructions

• Step 2: Select “Funding Opportunities”

Welcome Paolo Bomben

Organization Profile
Personal Profile
Change Password

Applications

Click here to view all of your applications.

Funding Opportunities
0 Draft Applications
0 Submitted Applications
0 Approved/Declined Applications
Online Portal Instructions

• Step 2: Select “Apply Now” for the Carbon Fibre Grand Challenge

Funding Opportunities

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Competition Name</th>
<th>Competition Deadline</th>
<th>Program Home Page</th>
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</thead>
<tbody>
<tr>
<td>Carbon Fibre Grand Challenge</td>
<td>Carbon Fibre Grand Challenge - Phase II</td>
<td>27/04/2021</td>
<td>Link</td>
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<tr>
<td>Postdoctoral Fellowships in Health Innovation 2+1</td>
<td>PFHI 2020/2021 Competition</td>
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<td>Health Innovation Continuous Intake</td>
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<td>Clean Resources Continuous Intake</td>
<td>Clean Resources Continuous Intake</td>
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<td>Link</td>
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<tr>
<td>Industry Commercialization Associates</td>
<td>Industry Commercialization Associates - Continuous Intake</td>
<td></td>
<td>Link</td>
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<tr>
<td>Industry r&amp;D Associates</td>
<td>Industry r&amp;D Associates - Continuous Intake</td>
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<td>Micro-Voucher</td>
<td>Micro-Voucher - Continuous Intake</td>
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<tr>
<td>Voucher</td>
<td>Voucher - Continuous Intake</td>
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<td>Link</td>
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</tbody>
</table>
Online Portal Instructions

• Step 3: Fill out the application

New Grant

Application ID: [Input]

Cycle Name: [Optional]

Program Name: [Input]

The red * before a question indicates that it is mandatory for submission.

****Please click on Save Draft before beginning the Application****

Some functions of this Application, as well as any system generated fields, will not be present until a draft is saved.

Please Note: the Application DOES NOT save automatically; remember to save early and save often.

Instructions and Disclaimer

This Application form collects pertinent information about the Investment being requested. This enables Alberta Innovates to assess the merits of the proposed Application and its fit with our strategic priorities and corporate goals. The Applicant must complete the Application in its entirety. Applicants that fail to complete all mandatory sections may not be considered. It is essential that you read and understand the Program Guide before completing this Application. All capitalized words or terms which are not defined within this Application have the respective meaning as set out in the Program Guide or Investment Agreement. In this Application, the term “you” and “Applicant” are used interchangeably.

To complete this Application, move from left to right through the tabs above. If you require assistance in completing your Application, please contact the Alberta Innovates’ representative listed in the Program Guide. If you are unsure who to contact, please email inbox_grants@albertainnovates.ca.

The Application will be reviewed by experts who are within and potentially outside of Alberta Innovates. These experts will provide their recommendations to Alberta Innovates and Alberta Innovates may, at its sole and absolute discretion, provide constructive feedback to the Applicant based on the expert reviews. At no time will Alberta Innovates disclose information about the reviewers to the Applicant and the Applicant is not entitled to access or review the experts’ recommendations.

Alberta Innovates will use its reasonable efforts to inform the Applicant of the Investment determination made in respect of an Application in a timely fashion. Any failure to inform the Applicant of the Investment determination regarding an Application will not result in any obligation or liability of Alberta Innovates to the Applicant or any other interested party.

Alberta Innovates has sole and unchallenged discretion over its funding decisions, including but not limited to the decision to fund or not fund, or the amount, timing, and terms attached to such funding and Alberta Innovates owes no duty of reasonableness to the proposing party. All decisions of Alberta Innovates, including but not limited to the decision to propose funding, are final. Applicants are not liable for the Project and are responsible. Alberta Innovates is not an administrative agency, governing, or winning, and as such the funds are not necessarily intended for the purpose described by the Applicant and are subject to the terms and conditions of the Application.

Save Draft  Submit Application  Withdraw Application
• Step 3: Fill out the application
Step 4: Submit

202103084

Application ID: 202103084
Program Name: Carbon Fibre Grant Challenge

Cycle Name: Carbon Fibre Grant Challenge - Phase II

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Generate Application PDF

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By submitting this Application, the Applicant agrees to the foregoing and accepts that Alberta Innovates shall have no liability to the Applicant for any losses or damages the Applicant may suffer, sustain, pay or incur arising in any way from its engagement with Alberta Innovates or this Application.

Alberta Innovates will only provide copies of the Application, including any attachments, to the Applicant Representative. Accordingly, any change of the Applicant Representative should be to an individual who has the authority and permission to see the Application and any attachments.

Save Draft ▼ Submit Application Withdraw Application
# Phase II Timelines

<table>
<thead>
<tr>
<th>Date</th>
<th>Planned Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 9, 2021</td>
<td>Launch of Grand Challenge Phase II</td>
</tr>
<tr>
<td>March 23, 2021</td>
<td>Webinar</td>
</tr>
<tr>
<td>April 27, 2021 at 2:00 PM MDT</td>
<td>Close of application submissions</td>
</tr>
<tr>
<td>Late May 2021</td>
<td>Successful Applicants Notified</td>
</tr>
<tr>
<td>June 2021</td>
<td>Contracting</td>
</tr>
<tr>
<td>July 2021</td>
<td>Phase II Projects begin</td>
</tr>
<tr>
<td>December 31, 2022</td>
<td>Latest completion date for funded projects</td>
</tr>
</tbody>
</table>
Advice for Preparing a Successful Submission

• Read the Program Guide
• Use clear and concise language
• Define what problem/challenge you are trying to address in Phase II
• Define who the end-users are for the carbon fibres you are trying to develop
• Address each question in the application template and read the question guidance carefully
• Give serious thought and a detailed answer to the question of how your solution to producing carbon fibre will be implemented in Alberta and Canada
• Don’t wait until the last day to submit
FAQ’s

• Can projects or funding occur outside the province?
• What are examples of “project partners”?
• What costs are eligible for funding?
• Are there any stacking limitations?
• Will successful applicants be signing an agreement with AI or CRIN or both?
Contact Information

• Dr. Paolo Bomben (CFGc Program Manager), Paolo.Bomben@albertainnovates.ca

• Bryan Helfenbaum, P. Eng. (Chair, BBC Strategic Advisory Committee), Bryan.Helfenbaum@albertainnovates.ca
Thank you.