CO2-derived Nanoparticles for Polymer and Concrete Applications

The overarching issue of greenhouse gas emissions is well known in both scope and consequences. With over 30 billion tonnes of CO$_2$ emitted annually, humanity emits over 100 times its own weight in greenhouse gas emissions that accelerate climate change patterns unparalleled in recent history.

The technology provider has developed a process to convert harmful CO$_2$ emissions into valuable solid products. The technology provider uses an IP-protected process to create a portfolio of graphitic nanoplatelets (GNPs) and graphene derivatives using waste CO$_2$ and cheaply available solids such as graphite, fly ash, petroleum coke, etc. The produced nanoparticle powders have technically-validated applications as additives in the plastics, coatings, epoxy, adhesives, concrete, lithium-ion battery industries.

Of the various applications of the technology, a commercial example is one of their plant that captures up to 50 kilograms of CO$_2$ per day and produces a carbon-ceramic coating formulation designed to provide a corrosion-resistant barrier for immersion service concrete infrastructure. The technology provider will be scaling up their production scale to enable CO$_2$ sequestration of 100 kilograms of CO$_2$ per day.

The technology provider is interested to seek industry partners who are keen to explore licensing or joint development opportunities in the areas of fly ash, polymer reinforcement additives and additives for concrete mixes.

Potential Applications

The technology provider provides a platform CO$_2$ conversion technology to make a range of advanced nanomaterial additives for use in a range of industries such as concrete, plastics, epoxies, batteries, and pharmaceuticals. Along with the wide scope of end-use applications, the patent-pending technology is unique in its ability to sequester a significant amount of CO$_2$ emissions in any of the aforementioned applications, thereby coupling the benefit of greenhouse gas emission reductions with improving the performance of widely-used materials.

Technology Features & Specifications

The technology and applications are designed to solve industry-specific challenges in the concrete industry, which is a high-volume emitter of CO$_2$ emissions.

For concrete coating:

The technology provider utilizes a carbon-ceramic binding chemistry that has a similar density to the concrete substrate, facilitates a chemical bond upon application, and is therefore considerably less prone to catastrophic failure than a polymer-based solution. Additionally, the technology utilizes water as a solvent, has no volatile organic content (VOCs), and is chemically compatible concrete chemistry, which relies on cement hydration with water. From an environmental standpoint, it is also important to note that the technology can produce coating which has a total CO$_2$ footprint of less than 0.2kg CO$_2$/kg of product relative to 3-5kg CO$_2$/kg of polyethylene, epoxy or polyurea based solutions. Cement-based coatings usually have a 1-1.5kg CO$_2$ per kilogram of product.

For fly ash enhancement:

The technology provider utilises a proprietary, patent-pending technology which can chemically adsorb CO$_2$ emissions into exfoliated fly ash to produce enhanced fly ash (EFA) for use in concrete. It can sequester between 50 to 250kg of CO$_2$ from the atmosphere per tonne of EFA produced. Additionally, it can increase early and late concrete compressive strength by up to 32%.
secondary market of additives instead of competing with base materials such as fuels, concrete, or plastics as the additives market within each of these industries is well-developed, uses energy-intensive manufacturing processes, and allows a startup to disrupt the existing industry with lower volumes of production through performance enhancements.

Although the technology provider’s commercial efforts have been thus far focused on the corrosion-resistant coating designed for concrete infrastructure, it is important to recognize that the additives produced by the patent-pending CO\textsubscript{2} conversion process can be used to improve the energy capacity and retention of lithium-ion batteries, improve the performance of commercially used adhesives, reinforce structural epoxies like those used in automotive and aerospace applications, as well as improve the pharmaceutical efficacy of chemotherapy drugs like Doxorubicin and Gleevec.

**Customer Benefits**

Overall, the technology offers the following benefits:

- CO\textsubscript{2} uptake of up to 30% (on a mass basis) per tonne of graphitic nanoplatelets
- Provide corrosion resistance to concrete infrastructure in acidic environments
- Reinforce polymer resins such as Polyethylene, Polyurethane, Nylons, etc
- Reinforce concrete mixes by up to 35%
- Reinforce adhesives and epoxies mechanically in fracture toughness and tensile strength
- Enhance 10-15% additional capacity retention in lithium-ion and LMO batteries
- Facilitate advancements in pharmaceutical drug delivery, solar PV cells, etc

**Market Trends and Opportunities**

One of the major applications of the technology is in the concrete industry through the commercializing of CO\textsubscript{2} sequestered fly ash. For fly ash, there is a $5.97Bn annual global market and a $3.35Bn annual US market and $200M annual Alberta market. Additionally, concrete corrosion space has a $3.27Bn annual market.

For more information on technologies we have to offer, please visit our website at [https://www.ipi-singapore.org](https://www.ipi-singapore.org) or enquire at techscout@www.ipi-singapore.org