DE-FOA-0002687: Request for Information on Industrial Decarbonization Priorities

ADMINISTRATION

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INTRODUCTION

IperionX Limited's (formerly 'Hyperion Metals Limited') (ASX: IPX) mission is to be the leading developer of low carbon, sustainable, critical material supply chains focused on advanced U.S. industries including space, aerospace, electric vehicles and 3D printing.

IperionX's breakthrough titanium metal technologies provide the opportunity to create a low carbon, all-American titanium supply chain, with the potential to be more cost-effective than steel and aluminum. Our disruptive technology could make lightweight, high-strength titanium the clear metal of choice in countless industrial applications including electric vehicles, where lightweighting is essential.

IperionX's technologies have demonstrated the potential to produce titanium products which are sustainable, 100% recyclable, low carbon and with product qualities which exceed current industry standards. The Company also holds a 100% interest in the Titan Project, covering approximately 11,100 acres of titanium, rare earth minerals, high grade silica sand and zircon rich mineral sands properties in Tennessee, United States.

IperionX believes that its breakthrough technologies in combination with its Titan Project have the potential to allow the U.S. to develop low-carbon domestic critical material supply chains, which are directly applicable to the Advanced Manufacturing Office's mission to catalyze research, development, and adoption of energy-related advanced manufacturing technologies and practices to drive U.S. economic competitiveness and energy productivity.

IperionX's breakthrough technologies have the potential to make a significant contribution to the achievement of a low-carbon industrial sector in the United States, primarily through the approaches of:

1. Energy efficiency; and
2. Electrification and low-carbon fuels, feedstocks and energy sources

ENERGY EFFICIENCY

IperionX's low carbon titanium metal technologies

IperionX's breakthrough technologies have established it as a market leader in advanced titanium processing methods that offer the potential for low cost, low carbon titanium metal and powders from sustainable all-American recycled metal and critical mineral supply chains.

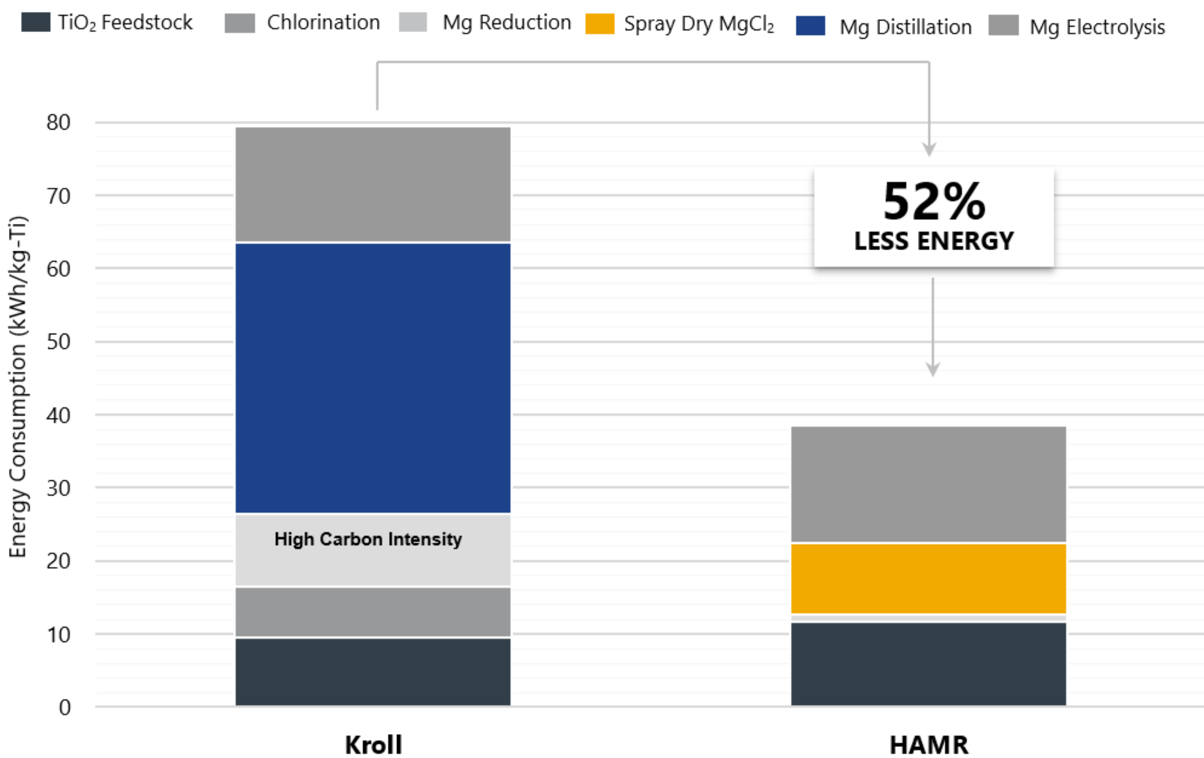
A technical challenge in titanium metal production is the difficulty in removing oxygen from titanium feedstocks, including scrap metal and titanium ores, and the subsequent propensity of purified titanium metal to rapidly pick-up oxygen and other impurities.

The current standard technology, the Kroll process, addresses these challenges via converting titanium ore (an oxide) into titanium tetrachloride ($TiCl_4$), and then reducing the chloride to titanium metal with magnesium. Unfortunately, the incumbent Kroll process is both capital, energy, and carbon intensive.

IperionX's breakthrough hydrogen assisted magnesiothermic reduction ("HAMR") technology is a low cost, low-to-zero carbon titanium powder production process invented by Dr. Z. Zak Fang and his team at Blacksand Technology, LLC in collaboration with the University of Utah and in conjunction with Boeing and Arconic as industrial partners with funding from the DOE's ARPA-E program.

The HAMR technology utilizes hydrogen to destabilize Ti-O, making it possible to turn the reduction of TiO_2 with magnesium from thermodynamically impossible to thermodynamically favored. This allows TiO_2 to be reduced and deoxygenated directly by magnesium to form TiH_2, with low oxygen levels that can meet the needs of the industry. TiH_2 can be further processed to titanium metal through standard industry methods.

Through this method, IperionX's breakthrough HAMR process reduces the energy intensity and resulting carbon emissions of producing titanium metals.



Over US$10m has been invested through the DOE's ARPA-E program and others to develop the HAMR technology from lab scale to pilot scale, and IperionX is operating a pilot scale titanium metal and powder plant in Salt Lake City, currently producing titanium metal from 100% scrap titanium feedstock.

Further information on the research can be found on the University of Utah's website (https://powder.metallurgy.utah.edu/research/hamr.php) and on ARPA-E's website (https://arpa-e.energy.gov/impact-sheet/university-utah-metals).

ELECTRIFICATION AND LOW-CARBON FUELS, FEEDSTOCKS AND ENERGY SOURCES

Step change in recycling of titanium feedstocks

The manufacturing of titanium components and structures can generate a large amount of titanium machining chips (this 'scrap' can be over 90% for complex traditionally milled parts). However, titanium is not 100% recyclable with the current industry process, as titanium scrap readily absorbs oxygen and therefore remelting requires a mix of new titanium sponge (from the Kroll process) and recycled titanium to maintain homogeneity.

Titanium scrap has a <50% recirculation rate, with most scrap being sold into the ferrotitanium market. Additionally, 10-20% of new titanium sponge production is typically "off-grade" and sold as ferrotitanium, as current technology does not allow for the iron impurities to be removed from titanium.

IperionX's HAMR technology breakthrough was the discovery that hydrogen destabilizes the Ti-O bonds making it thermodynamically favorable to reduce Ti-O with Mg and allows for reduction and de-oxygenation of titanium oxides from titanium concentrate and scrap metals, and revolutionizes the primary / virgin mineral to metal production, enabling 100% recycling of scrap titanium to new titanium metal.

Electric vehicle light weighting

IperionX's breakthrough technologies also enable the potential for the low-carbon production of titanium metal for light weighting of electric vehicles, as well as a low-carbon substitute of other high carbon materials in vehicles.

Titanium offers excellent strength to weight ratio, high performance in corrosive, high temperature and high stress environments, but has been historically limited in use due to high costs. Today, stainless steel and aluminum are the primary metals used in place of titanium, but their production remains a substantial source of emissions.

- Steel production accounts for approximately 8.5% of global CO_2 emissions while aluminum accounts for as much as 2%
- 2.9 tonnes of CO_2 are produced per tonne of stainless steel and approximately 12 tonnes of CO_2 are produced per tonne of aluminum

IperionX's titanium metal technologies provide a potential pathway to low cost, low-to-zero carbon, recyclable, and traceable titanium product in many vehicle applications, including battery packs for EVs as well as widespread applications in heavy haulage.

Based on studies by the NACFE, titanium used for light-weighting in the largest, Class 8 trucks has the potential for the significant weight reductions and the ability to massively increase their haul capacity compared to current largely steel-based trucks, which in turn requires less truck-miles on the road to deliver the same payload, with a huge potential reduction on CO_2 emissions as a result.

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SELECT RFI RESPONSES

Category 5

1. What emerging decarbonization technologies could have the most impact in other manufacturing industries over the next 5-10 years, and 10-20 years?

High impact decarbonization technologies in the next 5-10 years include the development and scale up of energy efficient substitutes for existing technologies within any one industrial area.

An example of this includes IperionX's breakthrough hydrogen assisted magnesiothermic reduction ("HAMR") technology, which is a low cost, low-to-zero carbon titanium powder production process invented by Dr. Z. Zak Fang and his team at Blacksand Technology, LLC in collaboration with the University of Utah in conjunction with Boeing and Arconic as industrial partners with funding from the DOE's ARPA-E program. The current standard technology, the Kroll process, is capital, energy, and carbon intensive.

Scale up of the HAMR technology over the short to medium term presents the potential for a large decarbonization opportunity through the simple replacement of a high energy process with a low energy process to produce similar material.

Over a period of 10-20 years, significant scale up and significant capital investment could enable the opportunity for new technologies to totally replace inferior & carbon intensive materials with superior and lower carbon materials. An example of this includes the potential to replace carbon intensive steel and aluminum with low carbon titanium - a superior material in most applications.

2. What primary factors are driving decisions on demonstrations of new technologies that reduce GHG emissions? Which promising technologies are most appropriate for demonstrating in the U.S. marketplace? Which technologies are ready for pilot plant scale-up, and which are ready for commercial demonstration?

Many factors drive decisions on demonstrations of new technologies that reduce GHG emissions, including:

i. The potential for a new technology to create a "step change" in decarbonization
ii. The scale of the potential market for a new technology
iii. Barriers to entry associated with existing supply chain, and willingness for market participants to consider new technologies
iv. Access to capital to fund projects from lab scale to pilot scale and beyond
v. Willingness of Governments / public institutions to assist in the advancement of new technologies

IperionX's breakthrough low-carbon titanium metal technologies are well positioned to move from current pilot scale to commercial demonstration.

Given the national focus on decarbonization combined with geopolitical considerations – including the fact that the U.S. no longer has a commercial source of primary titanium metal for its aerospace and defense industries – the environmental, commercial and political environment is poised for scale up of IperionX's technologies.

3. What is the magnitude (e.g., output rate and cost) of potential pilot or demonstration scale projects that could be undertaken in the next five years? What are the most critical performance characteristics (e.g., efficiency, GHG emissions, capital or operating costs, product quality) these projects need to demonstrate?

IperionX believes that its titanium technologies have the potential to be scaled from pilot plant to initial demonstration (commercial) facility, and then to a full scale commercial build out in 2 – 5 years. Efficiency, GHG emissions, capital & operating costs and product quality are all important considerations. However, given the typical high end industries where titanium use is widespread, including military and aerospace applications, an inability to achieve a required level of product quality is very important, and may render a new titanium technology ineffective.

4. What limiting factors or challenges do these manufacturing industries face in broadly deploying decarbonization technologies in the United States?

Limiting factors or challenges facing new technologies that reduce GHG emissions are often related to cost or access to capital, including:

i. Lack of capital for private organizations to commercialize a technology beyond R&D stage
ii. Sunk capital in incumbent technology & associated manufacturing facilities means manufacturers are resistant to the high capital cost of implementing new technologies at industrial scale
iii. The unit cost of product produced via new technologies may only be attractive at industrial scale application, yet industry may not choose to apply new technologies at industrial scale until unit costs are attractive (a "chicken and egg" scenario)

Potential mitigators to some of these challenges include Government-led resources including programs such as the DOE Loan Program.

5. What DOE resources would be most beneficial to accelerate decarbonization? For example:
   - RD&D options could include R&D projects, technology testbeds, pilot testing/demonstrations, and cost-share for commercial demonstrations.
   - Technical assistance options could include emerging technology validation, deployment assistance for new energy- and carbon-saving technologies, energy/carbon assessments, analysis tools, and workforce training.
   - Financial options could include the DOE Loan Program (access to capital, flexible financing).

All of the above listed DOE resources would be of benefit, however in IperionX's case financial resources associated with a demonstration facility and/or full scale commercial build out, including cost shares and Loan Programs, would enable the potential to accelerate the Company's development plans for low carbon titanium to be delivered for advanced U.S. industries.

6. How can technologies leading toward decarbonization of other manufacturing industries be commercialized and deployed with positive impacts to the surrounding community?

In developing its titanium metal technologies and Titan Project, IperionX is actively educating, training, and developing its workforce to support deployment of a technology that has a positive impact within the community. In 2021/2022 alone, IperionX employed over 15 full time staff, as well as 2 interns at its Pilot Plant in Utah, and is supporting 2 post-doctorate graduates from the University of Utah and has established the IperionX Scholarship Fund at the University of Utah, issuing 5 scholarships in metallurgical engineering, process engineering and materials science to date.