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Graphene Ceramic Composites for Hydrogen Separation Membranes (2014-127)

Composites that allow for cost-effective, stable separation and production of hydrogen.

Market Overview

The Clemson composite membrane provides robust hydrogen separation from mixed gas streams by transport mechanisms based on mixed ionic (proton) and electronic conduction. The global hydrogen generation market has been valued at $115 Billion as of 2017 and is expected to rise to $154 billion by 2022. This growth is influenced by hydrogen's use as a fuel source and other applications in the petrochemical, pharmaceutical, and chemical manufacturing industries. Currently, major issues with the process of hydrogen separation involve the cost and stability associated with separation membranes, which generally use expensive metals such as palladium and nickel. Clemson University researchers have designed a cost-effective alternative that implements graphene sheets rather than traditional metals. These novel graphene-ceramic composites are able to lower membrane production costs, provide higher operating temperatures than palladium, and demonstrate greater resistance to oxidation and expansion than nickel. Such improvements will allow for more efficient production of hydrogen, which will provide greater fuel accessibility and lower costs of other processes requiring it.

Application

Hydrogen Gas Generation/Alternative

Stage of Development

Prototype tested

Advantages

- Graphene is more cost effective than precious metals, reducing expenses associated with membrane separation.
- Composite design improves conductivity, allowing for enhanced separation performance.
- Composite design maintains integrity, reducing issues with thermal expansion during production.

Technical Summary

These novel composites combine graphene and ceramic materials to provide both ionic- (proton) and electronic-conducting pathways that serve to separate hydrogen from gas mixtures. They differ from traditional dense metal membranes by eliminating the use of expensive palladium or nickel metals which operate on a solution and diffusion mechanism of hydrogen transport. Use of graphene allows for improved conductivity and reduced thermal expansion over its nickel counterparts. This improvement is achieved in part by the structure of the graphene lattices whose hexagonal arrangement provide a highly stable and reactive structure. Compared to the current palladium-containing composites, the graphene composites can operate at higher maximum operating temperatures. The presence of graphene also provides improved sinterability via SPS process, allowing for the composites to be created with an already existing production method.

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App Type	Country	Serial No.	Patent No.	CURF Ref. Number	Inventors
Utility	United States	14/678,372	N/A	2014-127	Kyle Brinkman

About the Inventors

Dr. Kyle Brinkman is an Associate Professor within the Department of Materials Science and Engineering at Clemson University. He earned his Ph.D. in Materials Science and Engineering from the Swiss Federal Institute of Technology. Prior to coming to Clemson Dr. Brinkman was a postdoctoral fellow with the Japanese Society for the Promotion of Science and worked as a Principal Engineer for the Department of Energy Savannah River National Laboratory. Dr. Brinkman has been the co-P.I or P.I on over $5 million in sponsored research and has authored or co-authored over 100 peer-reviewed technical publications and government reports. He currently also serves as an Adjunct Professor at the University of South Carolina and serves as Materials Advantage faculty advisor for Clemson undergraduates. His research focuses on development of ceramics, fuel cells, energy materials, interfacial engineering, and crystalline materials for nuclear waste immobilization.

For More Information

This technology is being licensed in collaboration with the University of South Carolina Research Foundation. More information can be found by visiting http://techfinder.sc.edu/technology/15670 or by emailing technology@sc.edu.